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THEY ARE BOTH FINE HORSES BUT THEY PULL BEST HITCHED DOUBLE

The First American Locomobile

By F. R. Low

SYNOPSIS—A self-contained superheated steam-driven unit which turns out an indicated horsepower on a trifle over a pound of coal per hour, in sizes of less than 200 horsepower capacity.

Take a high-class compound engine, mount it upon its boiler, so that the cylinders are in the smoke box and the steam passes from the superheater directly to the high-pressure cylinder, and from the high-pressure through a reheater directly to the low without extraneous piping. Run the condenser and feed pumps from the engine itself so that the unit constitutes a complete steam plant with all its accessories, and you have what has been known for years in Europe as a "locomobile."

The amount of fuel used by these units is surprisingly small, and it was the adoption of a self-contained steam plant of this sort for its propulsion that gave the name Locomobile to a well known American motor car. These units, not at all of the rough-and-ready order of the ordinary portable outfit, but highly finished and adapted to the ornate surroundings of the high-class continental power plant, are in very common use abroad. Much has been published in POWER and elsewhere concerning their performances, and wonder has been expressed that no American manufacturer has undertaken to supply them.

It has at last been our pleasure to see a real locomobile built by American engineers in an American shop, and it is logical and natural that this shop should be that of the company that early recognized that the field of the old throttle-valve engine was limited and built the first automatic cutoff engine west of the Alleghanies, which built the first American steam-engine indicator, which was the first American shop to use blueprints, which was close upon the heels of the gas-engine development, and which has always been upon the firing line of progress, the Buckeye Engine Co., of Salem, Ohio.

Whence the "Buckeyemobile," as their new product is destined to be known. For more than a year they have been at work developing and testing out the new machine, and would not allow attention to be directed to it until it had demonstrated its practicability and worth by months of service.

Fig. 1 is an exterior view of the unit, the makeup and

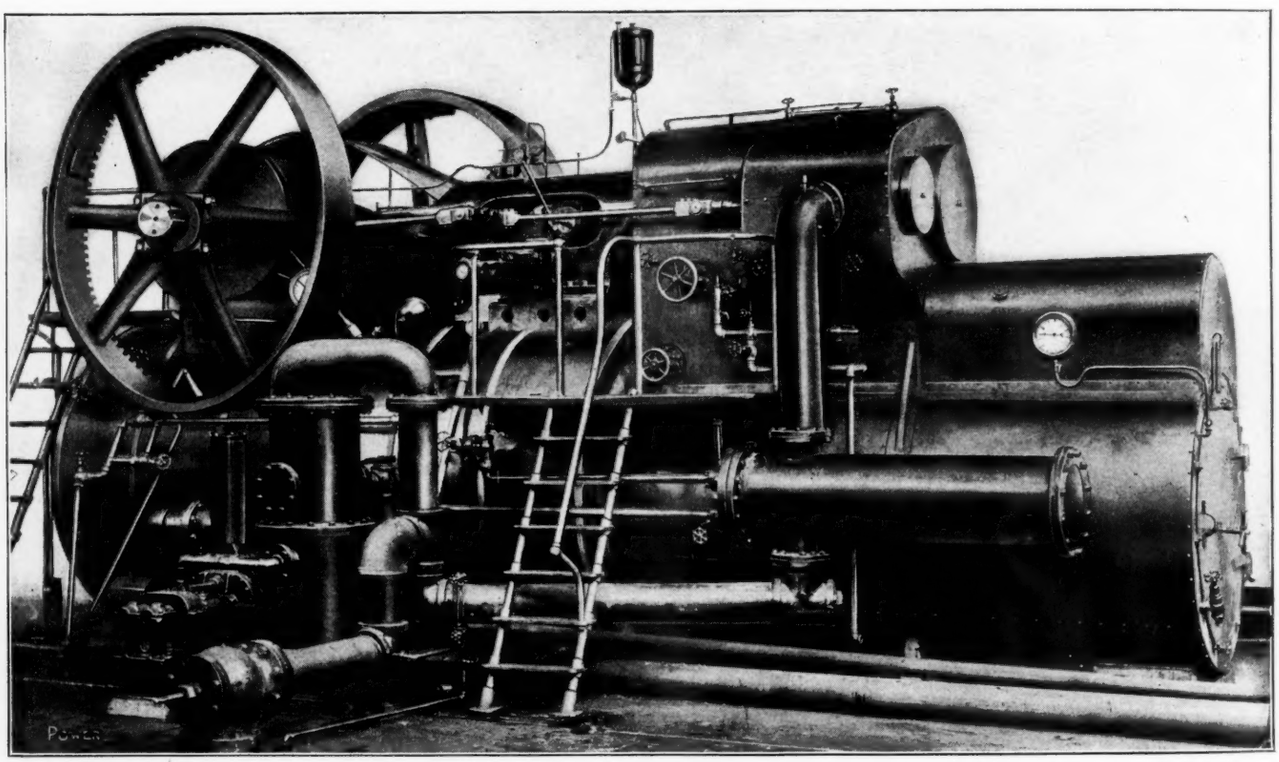


FIG. 1. THE BUCKEYEMOBILE OR FIRST AMERICAN LOCOMOBILE ON TEST FLOOR

component parts of which will be understood from the plan, elevation and longitudinal cross-section in Figs. 2, 3 and 4, and from the views of the dismantled engine shown in the other reproduced photographs.

Referring first to Fig. 4, the gases, after passing through the boiler tubes, impinge upon the superheater which consists of a continuous coil of seamless drawn-steel tubing, 3 in. in outside diameter, shown in place in Fig. 5, and then through the reheater, consisting of loops of 1-in. seamless tubing expanded into headers, as shown in Fig. 6, after which they escape by the discharge passage as indicated. The space above the superheater and reheater is not shut off and the gases are free to rise around the cylinders and connecting piping. No attempt has been made to heat the feed water with the gases.

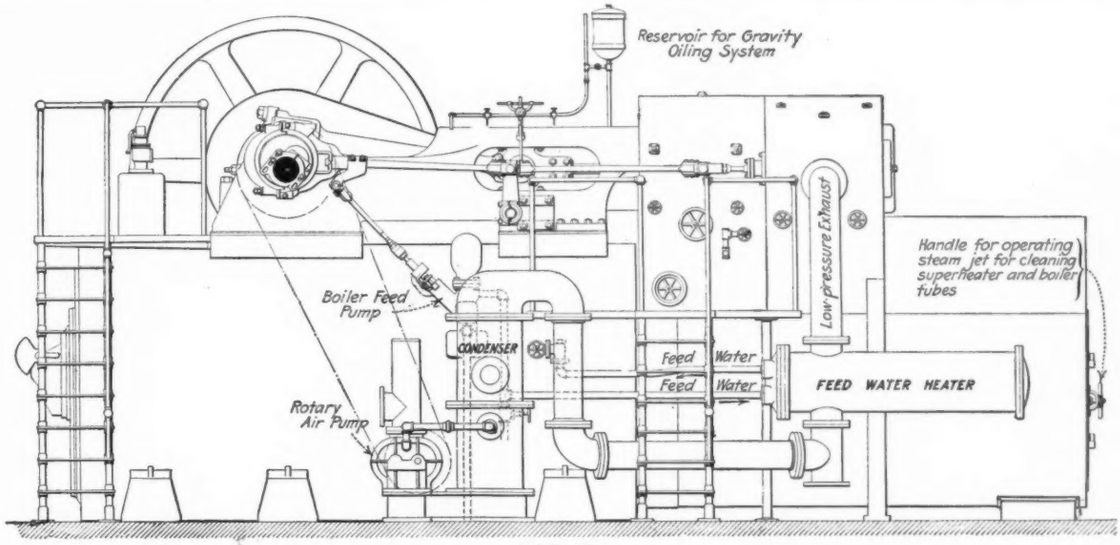


FIG. 2

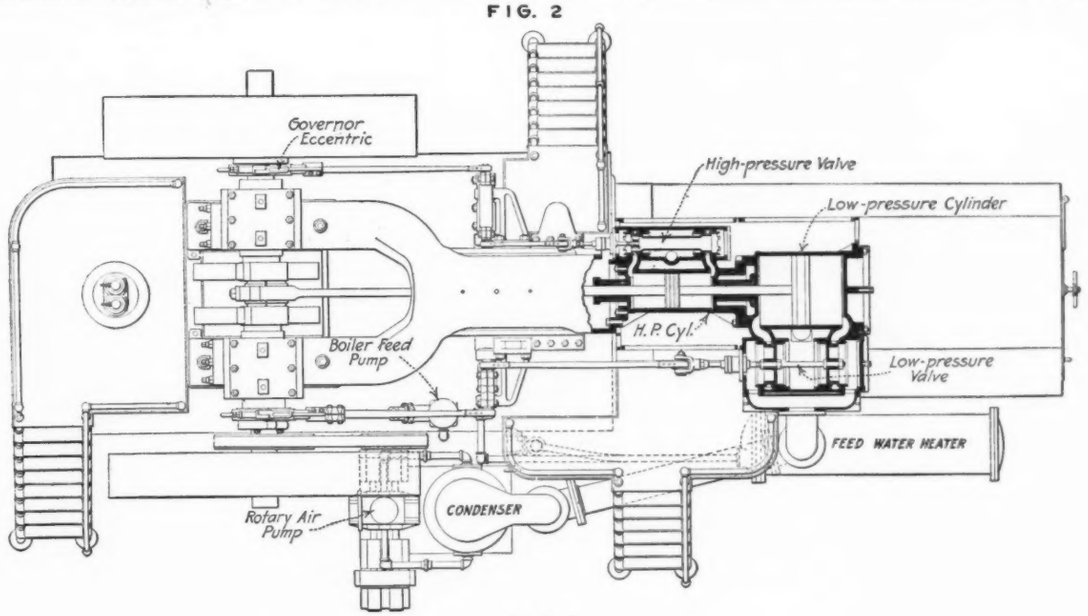


FIG. 3

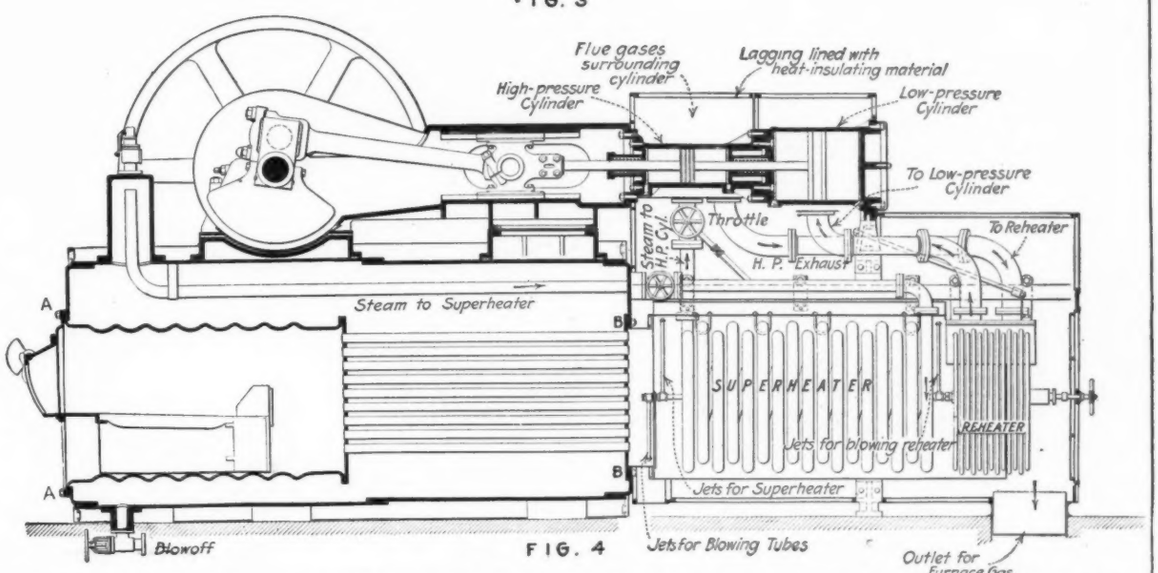


FIG. 4

ELEVATION, PLAN AND LONGITUDINAL SECTION OF THE FIRST BUCKEYEMOBILE

POWER

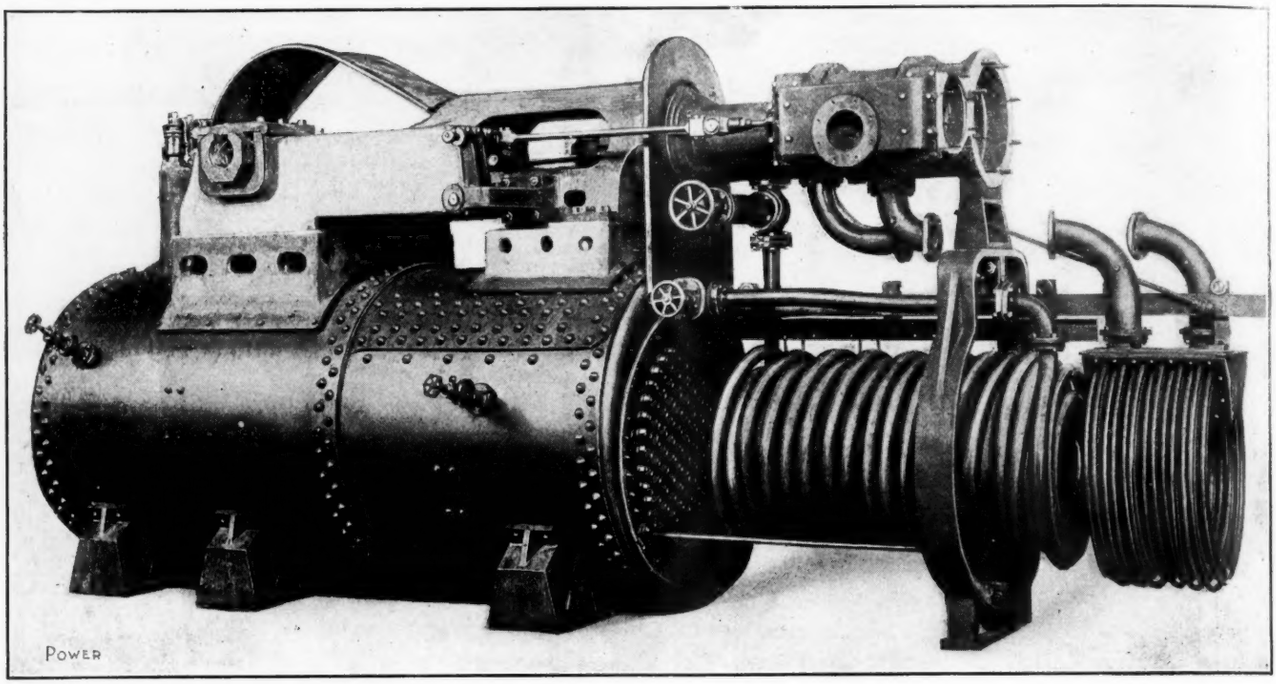


FIG. 5. BUCKEYEMOBILE STRIPPED OF LAGGING, JACKET, ETC.

The steam is taken from the steam dome, and passes, as shown in Fig. 4, into the far end of the superheater, returning in a direction counter to that of the gas flow, passing into the high-pressure cylinder just after contact with the hottest gases. Leaving the high-pressure cylinder it passes through the reheater and to the low-pressure cylinder, whence it is discharged through the feed-water heater to the condenser.

As is consistent with a self-contained unit the boiler is internally fired, requiring no setting, avoiding losses from air infiltration, etc. It is significant of the economy of the combination that with the steam furnished by this little boiler, having only 9 sq.ft. of grate surface and about 370 sq.ft. of heating surface, the unit has turned out 200 indicated horsepower.

By unbolting the flanges *A* and *B*, Fig. 4, the furnace and tubes can be removed, as shown in Fig. 7, for cleaning and inspection. This is no new expedient, but has been for years in successful use in German locomobiles.

The boiler is built in two courses of 7/8-in. sheets supported by three cradle brackets on each side, as shown in Fig. 7, and carries at its center a massive saddle which

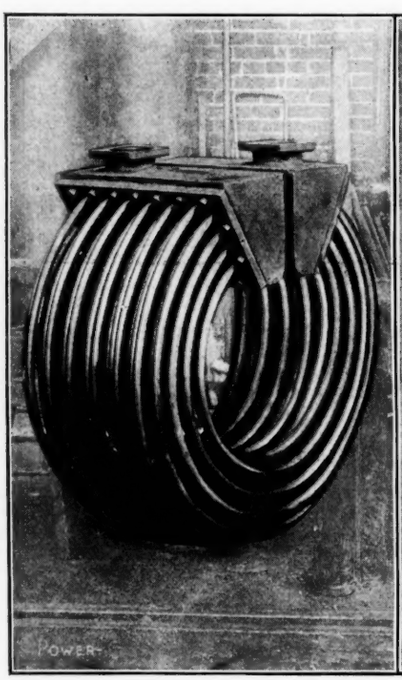


FIG. 6. REHEATER

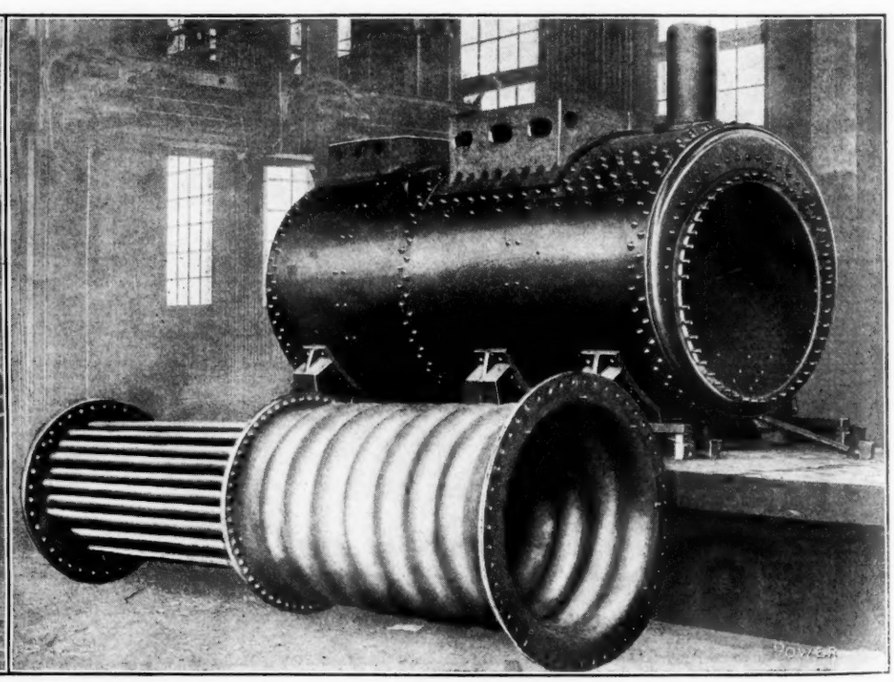


FIG. 7. BOILER WITH FURNACE AND TUBES REMOVED

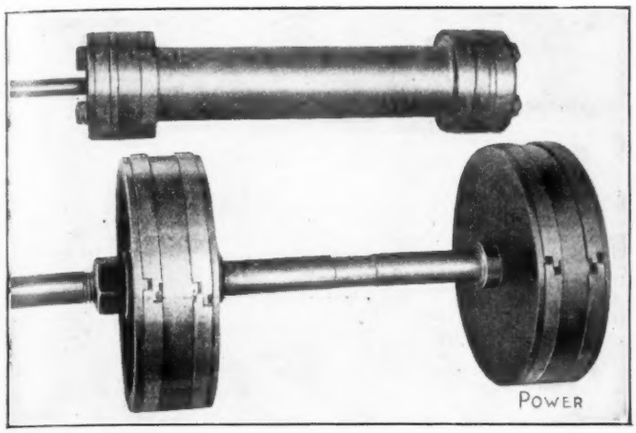


FIG. 8. VALVES AFTER MONTHS OF USE

spans about one-third of its circumference. To this the engine bed is rigidly secured at the main bearing end. The guide-barrel end rests upon a smaller saddle at the rear end of the boiler and is free to slide thereon, avoiding stresses from unequal expansion of the boiler and the

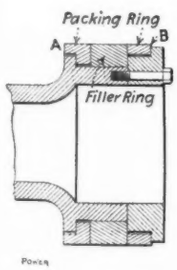


FIG. 9.

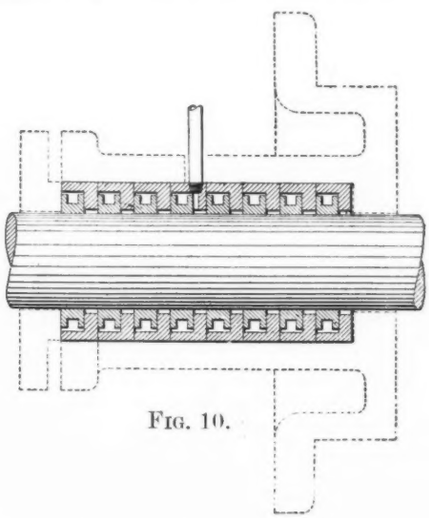


FIG. 10.

engine frame. The engine cylinders overhang the rear end of the boiler and are supported by a frame carried upon the foundation, as shown in Fig. 5.

The high-pressure cylinder is nearest the frame and the throttle valve is brought to the outside of the casing by extending its bonnet, as shown in the same view. It is again significant of the small steam requirements of the engine that this throttle valve is only 3 in. in diameter, while the valve between the boiler and the superheater is only 2½ in. The heaters are seen to be freely suspended in the path of the gases, and steam blowers indicated in Fig. 4 (the operating handle of which is seen at the right-hand end of the boiler) are provided to clean the surfaces when in operation.

The engine is shown in horizontal and vertical section in Figs. 3 and 4. The cylinders are 9½ and 19 in. in diameter, stroke 18 in., speed 200 r.p.m. Normal rated capacity 175 ultimate, 235 i.hp. Piston valves are used, taking the steam in the center and exhausting at the ends. A photograph of these valves taken after two months ofu se is reproduced in Fig. 8. The writer saw them after they

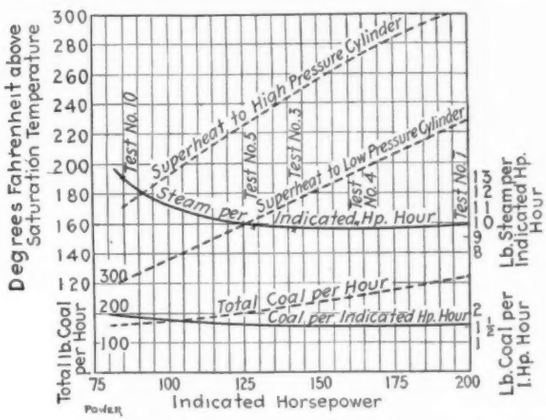


FIG. 11. TEST RESULTS OF BUCKEYEMOBILE

had been used for several months, and, although they have been used with high degrees of superheat, they show no evidence of lack of effective lubrication. Positive feed lubrication with leading pipes whereby the oil is discharged directly upon the surfaces to be lubricated is used for the high-pressure cylinder while for the low-pressure the oil is fed in with the steam. A simple and effective gravity-oiling system takes care of the bearings, all the oil used being gathered at one point and passed through a filter preparatory to being used over again.

As the rings in the valves constitute the working edges, those on the inside controlling the admission to the high-pressure cylinder are made of the section shown in Fig. 9, giving a sharp unobstructed edge at *A* for admission and cutoff. The control of release and compression by the edge *B* of the other ring or of the valve need not be so abrupt. The high-pressure valve is hollow and symmetrical with thin walls, conducive to keeping its shape under temperature variations, and its interior is filled with exhaust steam, which aids in keeping its temperature within limits. The packing used upon the rods and

RESULTS OF SPECIAL TESTS OF BUCKEYEMOBILE

No.	Date	Speed, r.p.m.	I.hp.	B.hp.	Mech. eff., per cent.	Mean Effective Pressure: High-pressure cylinder	Mean Effective Pressure: Low-pressure cylinder	Mean Effective Pressure: Referred to low-pressure	Water: Per b.hp-hr., lb.	Water: Per i.hp.-hr., lb.	Coal: Per b.hp.-hr., lb.	Coal: Per i.hp.-hr., lb.	Pressure: Avg. boiler press., lb. gage	Pressure: Avg. vacuum, in.	Superheat: High-pressure cylinder, F. deg.	Superheat: Low-pressure cylinder, F. deg.	Length of run, hr.	Coal
3	Oct. 14	195.5	142.2	127	89.3	67.5	12.02	28.47	10.82	9.65	1.75	1.56	196.5	27.15	256	214	3	Slack & Holwick
4	Oct. 25	197.6	162.	148	91.35	73.6	14.2	32.15	11.08	10.01	1.65	1.51	206.5	26.62	273	193	2	Holwick
5	Oct. 26	205.5	128.2	115	89.7	58.9	10.1	24.42	10.9	9.78	1.8	1.61	201.5	28.58	227.6	164.1	3½	Pittsburgh
6	Oct. 28	205.9	163.5	154	94.18	71.7	13.7	31.2	11.45	10.8	1.72	1.62	198.5	27.27	273.5	196	4.1	Pittsburgh
7	Oct. 29	206.6	200	192	96	83.2	17.9	38.11	10.25	9.9	1.67	1.6	204	27.23	302	229	3.05	Pittsburgh & Holwick
10	Nov. 6	205.6	84.6	77	91.01	9.5	6.6	16.1	14.65	13.3	2.14	1.95	200	27.75	170.4	119.5	3	Holwick
				kw.	overall effici'cy	load factor					per kw.-hr.							
11	Mar. 30	206	150.2	93.4	83.4	74.8%					2.99	1.856	208		262	189	3.5	Salem, good quality
12	Mar. 30	206	160.1	95.6	80.04	76.5%					2.35	1.40	208.5	23.25	263	189.4	3	Salem, good quality

Daily Summary of the Performance of the Buckeyemobile on Shop Load

Date	Time Start	Time Stop	Hr. Run	Total Lb. Coal	Coal per Hr.	Total Kw. Hr.	Aver. Load, Kw.	Load Factor, Per cent.	Coal per Kw.hr.	Coal per I.hp.hr.	Method of Operating	Average* Vacuum	Remarks
Jan. 30....	8:30 a.m.	5:30 p.m.	9	2260	251	715	79.5	63	3.16	1.84	Condensing	....	Salem Mine coal.
Feb. 10....	12:30 p.m.	5:30 p.m.	5	1486	297	465	93.0	74.4	3.20	1.895	Condensing	....	Salem Mine coal. Poor grade. Full of dust.
Feb. 11.....	12:30 p.m.	5:30 p.m.	5	1474	295	480	96	76.8	3.12	1.93	Noncondensing	....	Pittsburgh coal. 14,348 B.t.u.
Feb. 12....	12:30 p.m.	5:30 p.m.	5	1232	246.5	440	88	70.5	2.8	1.65	Condensing	....	Pittsburgh coal. 14,348 B.t.u.
Feb. 14....	12:30 p.m.	5:30 p.m.	5	1361	274	465	93	74.4	2.95	1.75	Condensing	....	Pittsburgh coal. 14,348 B.t.u.
Feb. 15....	8:00 a.m.	11:30 p.m.	3½	782	227	285	81.4	65	2.745	1.63	Condensing	....	Pittsburgh coal. 14,348 B.t.u.
Feb. 17....	8:00 a.m.	5:30 p.m.	7¾	1900	245	720	93	74.4	2.64	1.56	Condensing	....	Holwick coal. 14,398 B.t.u.
Feb. 20....	1:45 p.m.	5:30 p.m.	3¾	1088	290	325	86.7	69.3	3.35	1.97	Condensing	....	Salem (full of dust) 13,843 B.t.u.
Feb. 21....	1:05 p.m.	5:30 p.m.	4 5/12	1279	290	400	90.6	72.5	3.195	1.89	Condensing	....	Salem (full of dust) 13,843 B.t.u.
Feb. 24....	6:30 a.m.	5:30 p.m.	10	3032	303.2	925	92.5	74	3.59	1.94	Condensing	....	Salem (much dust) 13,843 B.t.u.
Feb. 25....	8:10 a.m.	2:30 p.m.	5¼	1290	242	433	81.2	65	2.98	1.74	Condensing	....	McNab hard coal. 14.09% ash. 12,723 B.t.u.
Feb. 25....	2:30 p.m.	4:30 p.m.	2	525	262.5	186	93	74.4	2.82	1.68	Condensing	....	McNab hard coal and Salem coal, 75% and 25% resp.
Feb. 26....	6:30 a.m.	5:30 p.m.	10	2548	254.8	865	86.5	69.2	2.94	1.73	Condensing	....	Salem coal. Run of mine. 13,843 B.t.u.
Feb. 27....	6:30 a.m.	5:30 p.m.	10	2892	289.2	990	99	79	2.93	1.74	Condensing	....	Salem coal. Slack. 13,760 B.t.u.
Feb. 28....	6:30 a.m.	5:30 p.m.	10	2683	268.3	915	91.5	73.2	2.935	1.74	Condensing	....	Salem coal. Slack. 13,760 B.t.u.
Mar. 1....	6:30 a.m.	11:30 a.m.	5	1301	260	460	92	73.5	2.83	1.68	Condensing	....	Salem coal. Run of mine. 13,912 B.t.u.
Mar. 3....	8:10 a.m.	5:30 p.m.	8½	2341	281	780	93.6	74.8	3.00	1.78	Condensing	....	Salem coal. Run of mine. 13,912 B.t.u.
Mar. 4....	6:30 a.m.	5:30 p.m.	10	2805	280	980	98	78.4	2.86	1.706	Condensing	....	Salem coal. Run of mine. 13,912 B.t.u.
Mar. 5....	6:30 a.m.	5:30 p.m.	10	2717	271.7	870	87	69.6	3.12	1.84	Condensing	....	Salem coal. Run of mine. Contains slate. 13,912 B.t.u.
Mar. 6....	6:30 a.m.	5:30 p.m.	10	2641	264.1	876	87.6	70	3.02	1.78	Condensing	....	Salem coal. Run of mine. Rogers coal. In use at 11 a.m. 13,912 B.t.u.
Mar. 7....	6:30 a.m.	5:30 p.m.	10	2589	258.9	845	84.5	67.6	3.06	1.80	Condensing	....	Rogers Ohio 13,515.37 B.t.u.
Mar. 8....	6:30 a.m.	11:30 a.m.	5	1120	260	390	78	62.4	2.87	1.936	Condensing	....	Rogers Ohio coal mixed with Salem run of mine.
Mar. 10...	6:30 a.m.	5:30 p.m.	7	1753	251	600	85.4	68.3	2.92	1.735	Condensing	24¾	Salem run of mine. 13,843 B.t.u. Salem slack. 13,760 B.t.u.
Mar. 10...	12:30 p.m.	3:30 p.m.	3	785	262	270	90.0	72	2.91	1.805	Noncondensing	....	Salem run of mine. 13,843 B.t.u. Salem slack. 13,760 B.t.u.
Mar. 11...	6:30 a.m.	5:30 p.m.	7	1724	246	525	75	60	3.30	1.85	Condensing	23¼	Salem run of mine. Salem slack (full of dust). Rogers Ohio lump.
Mar. 12...	6:30 a.m.	5:30 p.m.	10	2566	256	770	77	61.3	3.33	1.93	Condensing	23¼	Salem run of mine. Salem slack (full of dust.)
Mar. 13...	6:30 a.m.	5:30 p.m.	10	2529	252.9	745	74.5	59.6	3.39	1.96	Condensing	22¼	Salem slack. Full of dust and much dirt. 13,760 B.t.u.
Mar. 14...	6:30 a.m.	5:30 p.m.	10	2035	203.5	770	77	61.3	2.64	1.53	Condensing	22¾	Salem run of mine. 13,843 B.t.u. Good coal. Free from dirt.
Mar. 21...	8:30 a.m.	5:30 p.m.	8	2312	289	730	91.25	72.8	3.17	1.965	Noncondensing	....	Rogers Ohio coal. Full of dust and dirt. 13,515 B.t.u.
Mar. 22...	6:30 a.m.	11:30 a.m.	5	1423	284.6	415	83	66.5	3.44	2.12	Noncondensing	....	Rogers Ohio coal. Full of dust and dirt. 13,515 B.t.u.
Mar. 24...	6:30 a.m.	5:30 p.m.	10	3502	350.2	840	84	67.2	4.16	2.57	Noncondensing	....	Rogers Ohio coal. Full of dust and dirt. 13,515 B.t.u.
Mar. 25...	2:00 p.m.	5:30 p.m.	3½	1000	285.5	345	98.6	78.8	2.90	1.82	Noncondensing	....	Salem mine coal. 14,000 B.t.u. Good quality, free from dirt.
Mar. 26...	6:30 a.m.	5:30 p.m.	10	2991	299.1	1005	100.5	80.4	2.98	1.785	Noncondensing	....	Salem mine coal 14,000 B.t.u. Good quality.
Mar. 27...	6:30 a.m.	5:30 p.m.	10	2920	292	950	95	76	3.08	1.83	Noncondensing	....	Salem mine coal. 14,000 B.t.u. Good quality. No dirt.
Mar. 28...	6:30 a.m.	5:30 p.m.	10	2920	292	890	89	71.2	3.28	1.94	Noncondensing	....	Salem mine coal. 13,750 B.t.u. Rodgers Ohio coal.
Mar. 29...	6:30 a.m.	11:30 a.m.	5	1371	274.2	430	86	68.8	3.19	1.97	Noncondensing	....	Salem mine coal. 13,750 B.t.u. Rodgers Ohio coal
Apr. 1.....	6:30 a.m.	5:30 p.m.	8½	2134	251	760	89.4	71.5	2.81	1.67	Condensing	24¼	Salem coal. 14,000 B.t.u. Good quality no dirt.
Apr. 2**...	7:30 a.m.	5:30 p.m.	9	2260	251	830	92.2	73.8	2.72	1.615	Condensing	24¼	Salem coal, 14,000 B.t.u. Good quality. No dirt.
Apr. 8**...	2:35 p.m.	5:05 p.m.	2½	697	278	220	88	70.4	3.16	1.77	Condensing	24¼	Salem mine. Stoker fired. Good quality. 14,000 B.t.u.
Apr. 9.....	9:10 a.m.	5:30 p.m.	7⅓	1838	252	620	84.6	67.6	2.97	1.725	Condensing	24¼	Shepherd coal, Salem, O. Stoker fired.
Apr. 10....	3:15 p.m.	5:30 p.m.	2¼	621	276	210	93.4	74.8	2.95	1.815	Noncondensing	....	Salem coal. 14,000 B.t.u. Good quality. Stoker fired.
Apr. 11....	1:50 p.m.	5:30 p.m.	3½	829	237	325	92.8	74.2	2.55	1.515	Condensing	23¼	Salem coal. 14,000 B.t.u. Good quality. Stoker fired.
Apr. 12....	6:30 a.m.	11:30 a.m.	5	1141	228.2	390	78	62.4	2.93	1.69	Condensing	24¼	Salem coal. 14,000 B.t.u. Good quality. Stoker fired.
Apr. 14....	6:30 a.m.	5:30 p.m.	10	2504	250.4	830	83	66.4	3.02	1.755	Condensing	26	Salem slack. 13,760 B.t.u. Full of dirt. Stoker fired.
Apr. 15....	6:30 a.m.	5:30 p.m.	10	2153	215.3	845	84.5	67.6	2.55	1.495	Condensing	25¼	Salem lump. 14,000 B.t.u. Good quality. Hand fired.
Apr. 16....	10:45 a.m.	5:30 p.m.	5¾	1256	218.2	525	91.3	73	2.39	1.415	Condensing	25¼	Salem lump. 14,282 B.t.u. Good quality. Hand fired.
Apr. 17....	6:30 a.m.	5:30 p.m.	10	2112	211.2	835	83.5	67	2.53	1.485	Condensing	25¼	Salem lump. 14,000 B.t.u Good quality. Hand fired.
Apr. 18....	6:30 a.m.	11:30 a.m.	5	1321	264.2	390	78	62.2	3.36	2.06	Noncondensing	....	Salem run of mine. 13,843 B.t.u. Hand fired.
Apr. 18....	12:30 p.m.	5:30 p.m.	5	1111	222.2	425	85	68	2.62	1.54	Condensing	25¼	Salem run of mine. 13,843 B.t.u. Hand fired.
Apr. 19....	6:30 a.m.	11:30 a.m.	5	1311	262.2	475	95	76	2.76	1.64	Condensing	25¼	Salem run of mine. 13,843 B.t.u Contained dust. Hand fired.
Apr. 21....	6:30 a.m.	11:30 a.m.	5	1115	223	375	75	60	2.97	1.719	Condensing	26	Salem run of mine. 13,843 B.t.u. Contained dust. Hand fired.
Apr. 21....	12:30 p.m.	5:30 p.m.	5	1187	237	410	82	65.6	2.89	1.68	Condensing	25¼	Salem run of mine. 13,843 B.t.u. Contained dust. Stoker fired
Apr. 22....	6:30 a.m.	5:30 p.m.	4¾	1340	282	405	85	68	3.32	1.94	Condensing	24¾	Salem slack. 13,760 B.t.u. Stoker fired.
Apr. 23....	6:30 a.m.	5:30 p.m.	10	2359	235.9	875	87.5	70	2.69	1.59	Condensing	24¾	Salem slack. 13,760 B.t.u. Stoker fired.
Apr. 24....	6:30 a.m.	11:30 a.m.	5	1201	240	405	81	65	2.96	1.73	Condensing	24¾	Salem slack. 13,760 B.t.u. Stoker fired.
Apr. 25....	6:30 a.m.	5:30 p.m.	10	2123	212.3	835	83.5	67	2.54	1.495	Condensing	25¼	Salem mine run. 13,843 B.t.u. Hand fired.
Apr. 28....	9:30 a.m.	5:30 p.m.	7	1874	267.7	720	102.9	82	2.60	1.56	Condensing	24¼	Salem mine run. 13,843 B.t.u. Hand fired.
Apr. 29....	6:30 a.m.	5:30 p.m.	10	2163	216.3	900	90	72	2.40	1.42	Condensing	26½	Salem mine run. 13,843 B.t.u. Hand fired.
Apr. 30....	6:30 a.m.	5:30 p.m.	10	2138	213.8	865	86.5	69	2.47	1.453	Condensing	25¼	Salem mine run. 13,843 B.t.u. Hand fired.
May 1.....	6:30 a.m.	5:30 p.m.	10	1821	182.1	835	83.5	66	2.18	1.28	Condensing	24¾	Pocahontas run of mine. Hand fired. 13,966 B.t.u.
May 2.....	6:30 a.m.	5:30 p.m.	10	1991	199.1	865	86.5	69	2.3	1.35	Condensing	24¾	Pocahontas run of mine. Hand fired. 13,966 B.t.u.†

* Vacuum referred to 30" barometer.
** Locomobile shut down from Apr. 2 to Apr. 8 to install extended furnace and stoker. †Wet coal.

stems is shown in Fig. 10. The rings are not split but simply strung upon the rod, and form in their ensemble a labyrinth packing which appears not to suffer from the high temperatures used, and which has kept the rods in excellent shape during the months of use. The intermediate packing, between the high- and low-pressure cylinders, is so placed that nothing but steam could leak inwardly through it when the engine is run condensing.

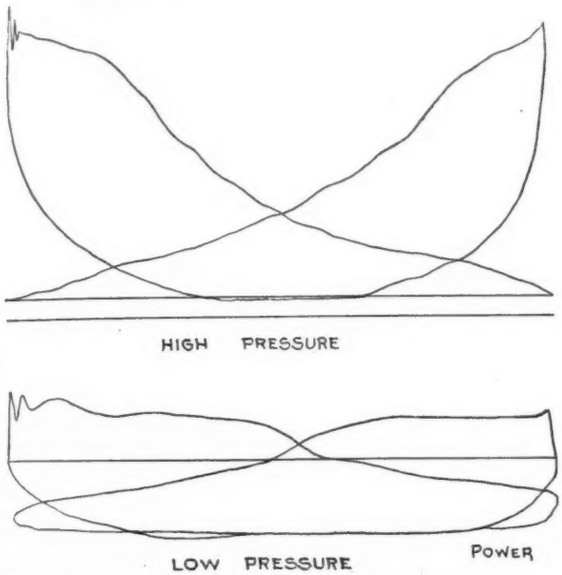


FIG. 12. TYPICAL DIAGRAMS FROM BUCKEYEMOBILE

Everything has been designed with a view to accessibility and it can be easily seen from the drawings how readily the combination of engine boiler and accessories can be taken apart.

A simple form of flywheel governor, controlling only the high-pressure valve, is used, and the results of years of Buckeye experience embodied in the handling of the engine portion. The second flywheel, is notched on the inner edge, as shown in Fig. 1, and a pawl and lever *A* and *B* provided for turning the engine over by hand. Attached to the strap of the low-pressure eccentric is the rod of the boiler-feed pump, Fig. 2. A Connersville condenser (POWER, Apr. 25, 1911, p. 661) is used, the rotary pump of which is driven by a belt from the main shaft. The unit under description has been under test in the Buckeye shops at Salem, Ohio, for months driving a generator to which it is direct connected through a flexible coupling. The generator is mounted upon a brick pier to bring it to the shaft level.

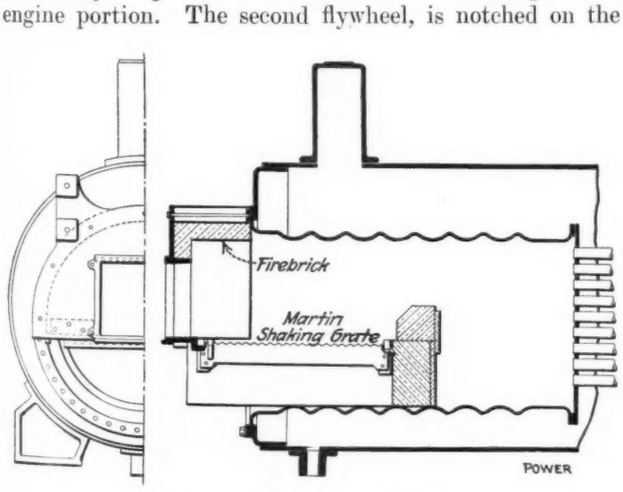
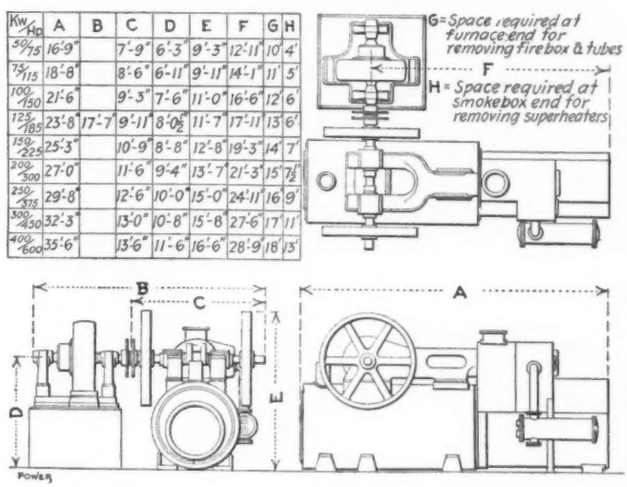


FIG. 13. EXTENDED FIREBOX

The photographs here reproduced have been taken while the engine was under development test and revision and do not at all bring out its possibilities with respect to appearance. In its normal condition it is neatly jacketed with sheet steel secured with polished-steel bands, lined with nonconducting material, and divested of much of the piping and apparatus incidental to its somewhat temporal and evolutionary condition.

The analysis of a test made in October is shown in Fig. 11. The engine developed an indicated horsepower on less than 9.75 lb. of steam per hour. Attention is called particularly to the flatness of the coal curve. The daily record is carefully kept and is epitomized in the following table. The unit delivers a kilowatt for about 2½ lb. of coal per hour, and an indicated horsepower-hour for some less than 1½ lb. condensing and little more than 2 lb.

Kw. / H.P.	A	B	C	D	E	F	G	H
50/75	16'-9"		7'-9"	6'-3"	9'-3"	12'-11"	10'	4'
75/115	18'-8"		8'-6"	6'-11"	9'-11"	14'-1"	11'	5'
100/150	21'-6"		9'-3"	7'-6"	11'-0"	16'-6"	12'	6'
125/185	23'-8"	17'-7"	9'-11"	8'-0½"	11'-7"	17'-11"	13'	6'
150/225	25'-3"		10'-9"	8'-8"	12'-8"	19'-3"	14'	7'
200/300	27'-0"		11'-6"	9'-4"	13'-7"	21'-3"	15'	7½'
250/375	29'-8"		12'-6"	10'-0"	15'-0"	24'-11"	16'	9'
300/450	32'-3"		13'-0"	10'-8"	15'-8"	27'-6"	17'	11'
400/600	35'-6"		13'-6"	11'-6"	16'-6"	28'-9"	18'	13'



CAPACITIES AND DIMENSIONS OF BUCKEYEMOBILES

noncondensing. Results of special tests are given in a second table. The performance of the engine is excellent, between nine and ten pounds of steam per indicated horsepower-hour.

The analysis of the coals used in the special tests are as follows:

Kind	Salem lump	Holwick run-of-mine	Pittsburgh lump	Pocahontas
Moisture %	1.63	.....	.....	2.30
Volatile %	41.17	42.65	35.50	18.95
Fixed carbon %	51.10	50.22	56.10	74.
Ash %	6.10	7.13	8.40	4.75
Sulphur %	3.63	1.94	2.12	0.58
B.t.u., per lb.	14,282	14,398	14.078	13,966.

Typical diagrams are shown in Fig. 12. Fig. 13 shows an extended firebox with which even better results have been attained, almost touching a pound of coal per horsepower-hour. We shall have more to say about these later tests in a future issue.

The combined electrical power output of the 7,500 central generating stations of the country aggregates 12,000,000,000 horsepower, according to one of the big electric light and power associations which has been gathering statistics on the amount of electric power generated in the United States. As an illustration of what an immense output that means, an electrical engineer says it would take 5,000,000 of the largest sized locomotives to exert this amount of power, and that it would be sufficient to propel 342,857 of the largest sized ocean steamships.—N. Y. "Tribune."

Heine Boiler Tests at Terminal Stations

SYNOPSIS—Some test figures of the performance of the boilers at the largest railway terminal station in the world. Superheated steam is used and the boiler settings are of special design.

The Grand Central Terminal of the New York Central & Hudson River R.R., recently opened to the public, is the largest terminal station of any railroad in the world, and covers an area of over seventy acres. At the north of the terminal, at Fiftieth St. and Park Ave., is situated the service plant, a building 160 ft. long by 90 ft. wide, of steel and brick construction, carried on steel columns above the tracks.

The service plant furnishes electricity for lighting, the operation of elevator and other motors, heat for all buildings within the terminal, and steam for heating of cars in the station. Fire and service pumps, freight-elevator pumps, compressors and miscellaneous pumps and boiler-plant auxiliaries are also installed.

The service station is primarily a heating plant. Steam required for heating cars within the terminal is drawn from the boilers through reducing valves. This load amounts to a large portion of the total in times of cold weather. The heating of all the various buildings within the terminal area is by hot water, heated by the exhaust steam of the various units in the power plant. At present the hot water is supplied at two pressures and temperatures in separate systems, but later when higher buildings are erected, a third system will be installed. The present low-pressure system circulates about 4500 gal. per min., and the intermediate-pressure system about 1000 gal. per min. The water is heated in three large "even-flow" exhaust-steam heaters, and is circulated by suitable motor-driven centrifugal pumps. The temperature of the water is recorded and regulated in accordance with the prevailing atmospheric conditions, thus eliminating the necessity of regulation at the radiators in any part of the system. The principal supply of exhaust steam at this time is derived from three General Electric turbines, driving 500-kw., 275-volt, direct-current generators.

The boiler equipment consists of 10 Heine boilers, six of 635 hp., and four of 550 hp. Space is reserved on the second floor, where these boilers are installed, for four additional 635-hp. boilers, and on the third floor there is space reserved for 14 boilers of a total rating equal to that on the second floor. The position of the boilers is shown in Fig. 1.

No. 2 buckwheat is fired at present by hand, but provision is made for future stokers, natural draft being provided by two steel-plate, brick-lined stacks, 17 ft. outside diameter and about 220 ft. high above the grates.

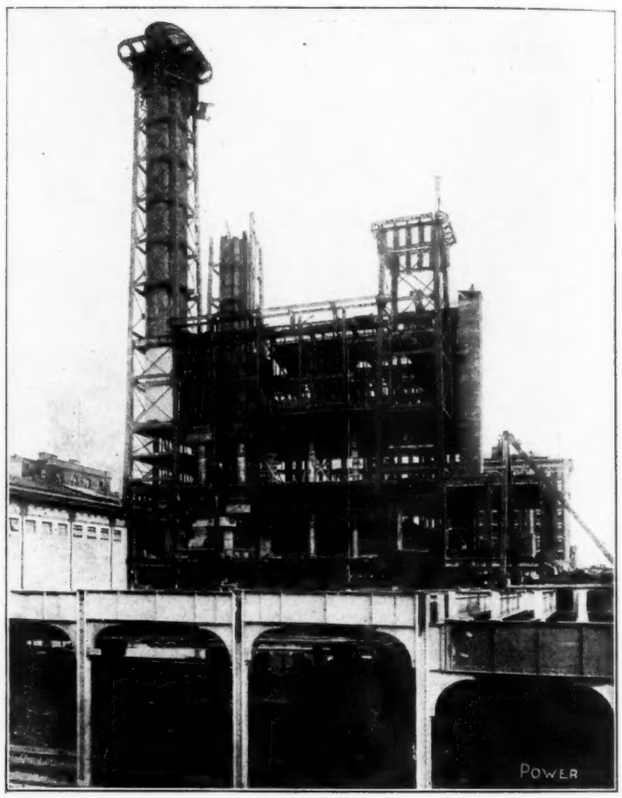


FIG. 1. HEINE BOILERS ON SECOND FLOOR OF THE GRAND CENTRAL STATION SERVICE PLANT

Forced draft when needed is furnished by two engine-driven blowers. Coal is delivered either by cars on the track level, or by trucks on the street level. It empties through chutes into a balanced skip hoist, which delivers it at the rate of 60 tons an hour to overhead storage bins of 3000 tons capacity. Ashes are removed from the first floor under the boilers.

ACCEPTANCE TEST OF A 635-HP. HEINE BOILER WITH SUPERHEATER AT GRAND CENTRAL STATION SERVICE PLANT, N. Y. CITY

Test	Oct. 30, 1912		Feb. 21, 1912
Square feet of shaking grates	125		125
Fuel	No. 1 Buckwheat		No. 2 Buckwheat
Coal Analysis	N.Y.C. & H.R.R.R. as received	Chemist dry coal	Harris Laboratory as received	New York City dry coal
Moisture	5.0		4.96	
Ash		17.93 per cent	20.92 per cent	22.02 per cent
B.t.u. per lb., coal		12,193	10,880.	11,448.
Duration of run		8.916 hr.		8.166 hr.
Total weight of coal as fired		24,640 lb.		26,075 lb.
Total weight of water fed to boiler		165,377 lb.		164,205 lb.
Coal per hour as fired		2763 lb.	(dry)	3035 lb.
Water per hour, actual conditions		18,546 lb.		26,040 lb.
Average steam pressure		179.5 gage		176 lb. gage
Temperature of feed water		62.7 deg. F.		41 deg. F.
Superheat		89.0 deg. F.		122 deg. F.
CO_2 by volume		13.80		
Hp. developed		675 hp.		755 hp.
Percentage of rating		106 per cent		119 per cent
Economic Results				
Water apparently evaporated per lb. coal, actual conditions		6.71 lb.		6.3 lb.
Equivalent evaporated from and at 212 per lb. coal as fired		8.43 lb.		8.16 lb.
Equivalent evaporated from and at 212 per lb. dry coal		8.87 lb.		8.58 lb.
Efficiency of boiler furnace and grate		70.5 per cent		72.67per cent.

In Fig. 2 is shown longitudinal and cross-sectional views of one of the 635-hp. Heine boilers with superheater. These boilers work at 180 lb. pressure, and 100 deg. superheat, and are of the two-drum type. Horizontal baffling is inserted so as to make two main passes for the gases. On the lowest row of tubes are placed a number of rows of firebrick tile, extending over the furnace, and back over the high bridge-wall, thus forming the roof of the combustion chamber. The middle baffle is located on the ninth row of tubes and consists of a special cast-iron baffle, extending from the rear water leg toward the front water leg with a sufficient opening for the passage of gases. On the top row are placed T-tiles similar to those on the bottom row. The travel of the gases is obvious. Attention is drawn to the fact that the effective path is long, and the boiler surface is compactly arranged, thus giving efficient absorption of heat in the hot gases even with the comparatively high furnace temperatures resulting from the combustion chamber formed by the tile over the furnace.

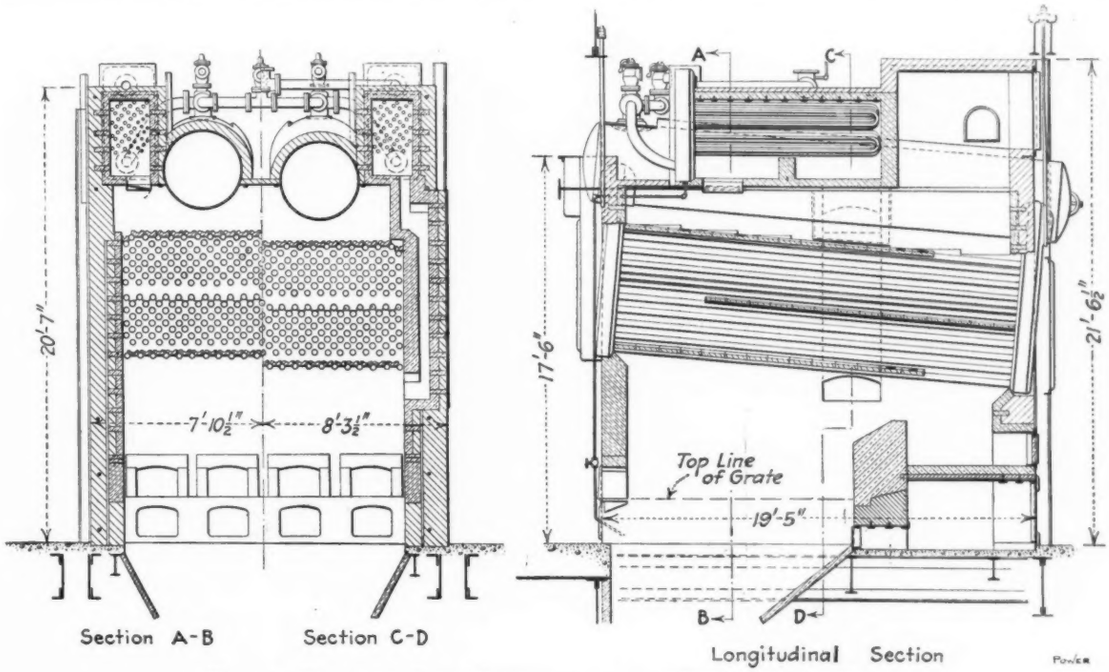


FIG. 2. END AND SIDE ELEVATION OF A 635-HP. HEINE BOILER

The superheater consists of two parts, one to the outer side of each drum. Each superheater is located above the water line, in a firebrick chamber formed in the setting, as shown. A flue connects the chamber directly with the furnace, and a small per cent. of the furnace gases flow up the flues and supply the heat to the superheater tubes. The hot gases make two passes over the superheater tubes, and then flow out of the superheater chamber at the end nearest the front header, so that before reaching the uptake and joining the boiler gases, they pass under the boiler drum. A damper in the superheater outlet gives complete control of the amount of gases flowing over the tubes, therefore permitting of temperature regulation and also of entirely cutting off the supply of hot gases when saturated steam is desired, or when there is no boiler load. No provision is made for flooding of the superheater as that operation is unnecessary.

The superheaters themselves are constructed of 1½-in. mild-steel, seamless-drawn tubing, bent in the form of U-elements, and expanded into box headers of a rectangular shape. Hollow stay-bolts in the headers permit of rapid and effective cleaning of soot from the superheater tubes, and handhole plates are provided for access to the tube ends. Within the headers there are two partition plates dividing the superheater box into three chambers and causing the steam to flow through the tubes in four passes.

The performance of one of these 635-hp. boilers is given by the test figures tabulated in the accompanying test tables. The tests were made with anthracite buckwheat Nos. 1 and 2 and natural draft and show efficiencies well above 70 per cent.

Interesting Repair to Elevator Plunger

An interesting mechanical job was recently done on the plunger of an Otis high-pressure plunger elevator, in the West building of the Prudential Insurance Co., Newark, N. J., by George H. Ward & Co., Brooklyn, N. Y.

The plunger had become so badly worn at the top, and the need for increased car travel so urgent, that a new plunger was needed. Because of the expense and delay which would be entailed by installing a new one, a novel repair to the old one was decided upon instead. This consisted in turning off the worn part to receive a cap which would renew the end of the plunger and increase its length, as shown in Fig. 2.

To get below the worn part of the plunger and to turn it down enough in length to receive the cap, required a portable boring bar designed especially for the job. The 7½-in. plunger was turned down to 6½ in. for a distance of 3 ft. The plunger was steel and was turned with a ¼-in. cut at a feed of $\frac{1}{16}$ in. Before turning the plunger and installing the boring bar, the car cables were put to one side of the shaft. The boring bar is shown in Fig. 1. The frame *A* is a hollow cylinder 6 ft. 7 in. long, bored, and with the inside face finished to act as a guide for the tool holder *B*. The split base clamp *C* was bolted to the

frame *A* with its other end slipped over the plunger to hold the latter while it was being turned. The upper end of the frame had a guide cover *D*, which served to guide the spindle *E*, which, in turn, drove the tool holder through the worm gear *F*. The spindle was made fast to

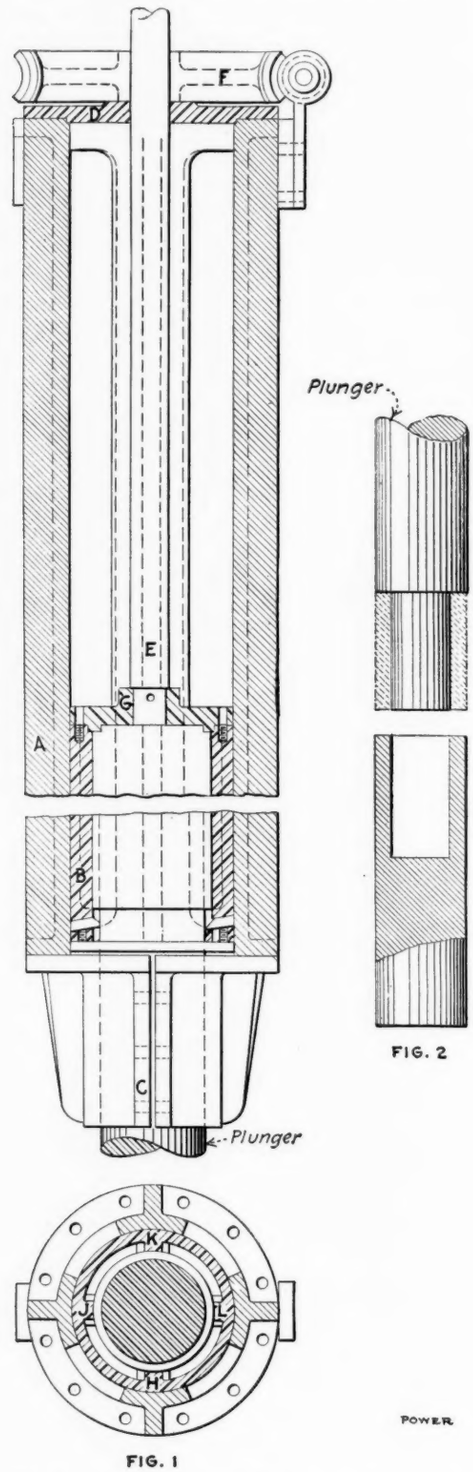


FIG. 1

PORTABLE BORING BAR FOR TURNING DOWN ELEVATOR PLUNGERS IN POSITION

the tool holder *B* by being keyed to a driver plate *G*, which was secured to the tool holder by ¾-in. tap bolts. The bosses through which the four tools were inserted are shown at *H*, *J*, *K* and *L*. These bosses were staggered so that one tool started a cut where another left off.

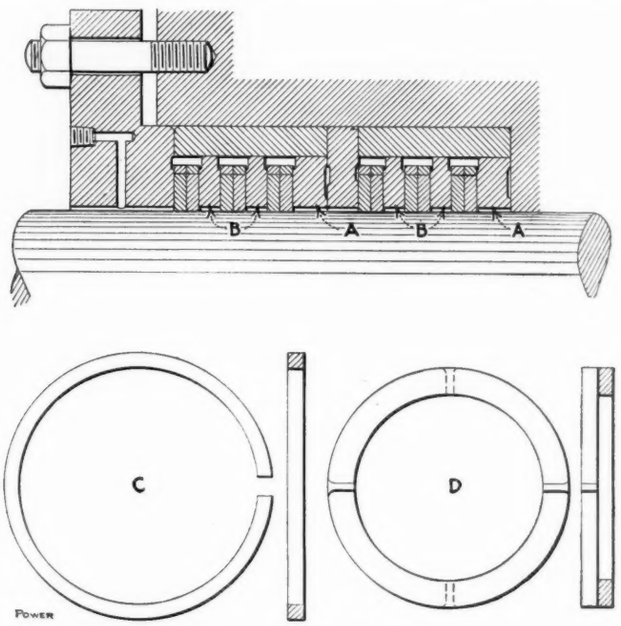
The machine was motor driven and also hand fed, as the conditions did not warrant the extra expense of power-feed mechanism.

Ward & Co. have done other interesting work on hydraulic elevators, such as reboring in position plunger cylinders of any length found in practice, without interfering with the service of adjacent elevator units.

Horton Gas-Engine Packing

A new packing for large gas engines has been designed to eliminate excessive friction and wear on the piston rod by preventing the closing of the collapsible ring under excessive pressure.

As shown herewith, the packing rings proper, *C* and *D*, are in contact with the rod. They are placed in grooves, the walls *A* and *B* of which are free to move in line with the rod and thus bind the packing rings against forcible



ROD PACKING FOR GAS ENGINE

closing at the time of the highest pressure in the cylinder. In practice it is found that this side clamping of rings does not affect the sealing quality of the packing, as contact with the rod is sufficient to prevent the passage of gas, but yet so light that wear cannot be detected on the rod. All rings and corresponding parts of the packing are interchangeable.

This packing was designed and patented by James Horton, efficiency engineer of the Homestead plant of the Carnegie Steel Co., and is made by the Metallic Packing & Manufacturing Co., Elyria, Ohio.

The John Scott legacy medal has recently been awarded to the Kennicott Co. on its water weigher or measuring device. This medal was awarded by the city of Philadelphia upon recommendation of the Franklin Institute for the promotion of the mechanic arts. The Institute made a thorough and extended investigation as to the merits of the device and this award was made "in consideration of its novelty, its simplicity of design, and its accuracy as a water-measuring device."

Electrolytic Prevention of Boiler Corrosion

At the sixty-eighth ordinary meeting of the Faraday Society, Apr. 4, 1913, Prof. W. W. H. Gee, of Manchester, delivered a lecture on the subject of the prevention of corrosion by electrolytic means. The corrosion of metals can be lessened in two ways: (1) By connecting the metal to be protected to a more electropositive metal, so that a primary cell is produced; (2) by making the metal to be protected the cathode in an electrolytic cell supplied by external electrolytic pressure. An example of the first is the suspension of zinc plates in a boiler; of the second an iron plate suspended in a boiler, the suspended plate being then made the positive pole, and the boiler the negative, by means of a generator. Sir Humphrey Davy's zinc-and-iron protection for the copper sheathing of ships, and the patents of Harris and Anderson, in which aluminum alloys are used for the prevention of the corrosion of boiler tubes, are also examples of class (1).

The efficiency of the cell for protection will depend on the current density of the cathode, and this will be controlled by the resistance of the cell and the effective voltage. In the use of zinc in boilers a knowledge of the electrolytic resistance of the boiler waters and the effective voltage from 300 to 400 deg. F. is desirable. For this information there is great need of experimental data. The amount of zinc used in some marine boilers amounts to 400 to 600 lb. per annum, and the current may be 17 to 25 amp. It is clear that using currents of this size, it is cheaper to generate the electric current by mechanical means (generator) than by chemical means (zinc plates).

The use of an external source of power and iron cathodes (certain modifications of which are covered by patent) not only prevents corrosion, but is said also to remove and to prevent boiler scale. Experiments carried on in the Manchester School of Technology have shown that the current densities necessary to prevent the corrosion of iron, copper and similar metals by fresh and salt water are of low value, and hence the cost of the electric energy required is a small matter. The chief cost will be the renewal of electrodes. Harris and Anderson have also applied electric currents to the prevention of corrosion in condensers. They find a condenser with a cooling surface of 1025 sq.ft. requires only 2 amp. at 2 volts pressure while the anodes cost £3¼ ($15.80) per 1000 sq.ft. of condenser surface per annum. Electric currents may also be used in chemical works to prevent the corrosion of metallic screens and vessels by acid liquids.

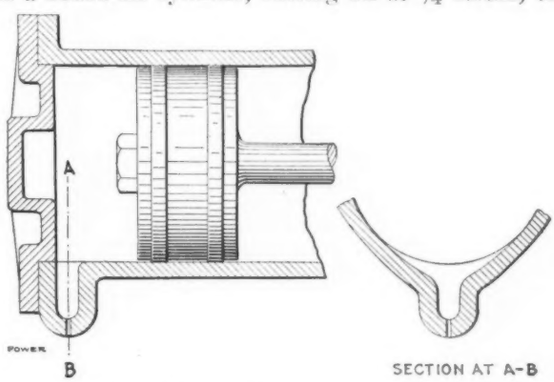
[On the basis of power at 0.6c. per kw.-hr., the current for condenser protection would cost only 21.02c. per year. That such an amount of current would use up almost $16 worth of electrodes seems absurd, but these are the figures given by Mr. Gee. There must be a tremendous amount of local action in the anodes he reported on.—Editor.]

To Avoid Cylinder Condensation

When the steam enters the cylinder of an engine it comes into contact with walls and surfaces which have just been exposed to the comparatively cool exhaust steam, and chilled by the evaporation of the water which was deposited upon them. The incoming steam condenses upon the surfaces with the result that, in an ordinary unjacketed engine with a ratio of expansion of four or five, there is about 20 per cent. by weight of water in the cylinder contents at the point of cutoff. Some of this water is reëvaporated during the expansion stroke as the pressure lowers, but most of it is reëvaporated after the exhaust valve opens, the reëvaporation being done at the expense of heat taken from the cylinder walls, which cools them for the next incoming charge.

H. Bollinckx, the well known Belgian engine builder, suggests the forming of a small pocket in the clearance of the cylinder, as shown in the accompanying sketch, into which this water may drain, and from which it may be blown out through the small hole shown.

In a 20x32-in. cylinder, cutting off at ¼ stroke, there would be, with 20 per cent. initial condensation, about 3 cu.in. of water in the cylinder at the point of cutoff. It is not improbable that a considerable quantity of this would find its way into the little well during the period of admission and expansion, and would have escaped by the time the exhaust valve opened, so that it would not chill the surfaces by its reëvaporation. Engineers have a propensity to run with the drip valves cracked a bit open. Perhaps their observation has suggested a possible advantage in this direction.



Pocket to Entrap Cylinder Condensation

No patent has been taken out on the idea and anyone desiring to make use of it is at liberty to do so.

Large English Condensing Plant

Another large surface-condensing plant, duplicating one already installed, has been ordered for the Leeds Corporation Electricity Works, Leeds, England, from the Mirrlees Watson Co., Ltd., Glasgow, Scotland. The plant will be capable of handling 130,000 lb. of steam per hour, and will be connected to a turbo-alternator, which will be built by Willans & Robinson, Rugby, England. The condenser is of a very special design on account of the dirty water obtained for condensing purposes from the river Aire. This water contains a large amount of woolen material, which, along with mud, soon clogs up the ordinary type of condenser. The condenser is designed so that all the tubes can be cleaned out while the plant is in operation. The flow of the cooling water can be reversed without interfering with the running of the plant. The condenser is of the vertical type and has 24,800 sq.ft. of cooling surface. Its total height is 28 ft. and weight 85 tons.

ELECTRICAL DEPARTMENT

Care and Operation of Commutators*

By H. S. Page†

The successful and economical operation of a direct-current plant is largely dependent upon the proper maintenance of commutators and brushes. Numerous improvements in the design of direct-current apparatus are constantly leading to higher speeds and to greater capacity of units. This, in turn, necessitates not only better commutators, brushes and brush rigging, but a more definite understanding, on the part of operating engineers,

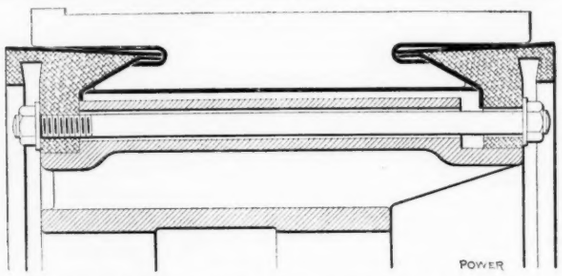


Fig. 1. Arch-Bound Type of Commutator

with regard to the proper care to be exercised in order to minimize the maintenance expense.

The primary requirement in the construction of a commutator is that the mica and copper segments shall be held firmly in a compact arch and be so supported that there is a minimum tendency toward distortion, resulting from centrifugal stresses or from alternate heating and cooling. This is accomplished generally by two methods: In the first (Fig. 1), the segments are built up in a cylindrical arch and are held in place by two wedge-shaped clamping rings, secured by bolts and supported on a shell or spider. Such a commutator has an actual clearance between the shell and segments and is known as the arch-bound type.

In the second (Fig. 2), the segments are held in place by clamping rings bolted together, and are also seated on the body of the shell. This is known as the body-bound type.

A few commutators, designed for exceptionally high speeds, are held together entirely by strings of high-grade steel, shrunk upon the outside at a tension greatly in excess of the centrifugal stresses encountered at maximum speed.

It has been a common practice, especially on new commutators of the arch-bound and body-bound types, to tighten the bolts at the least indication of surface roughening. The necessity of tightening the clamping-ring bolts has been due to the whole structure loosening during the so called process of "seasoning." Commutators of recent manufacture, however, having an improved grade of mica, together with better proportioned rings and bolts, require little or no tightening; in fact, such a practice may be very detrimental as the clamping ring may be drawn out of shape or dished, and the copper segments forced out of position. This action will not take place uniformly around the periphery and the commutator will accordingly have displaced bars and show all the indications of being loose.

Too much importance cannot be placed upon the proper staggering of brushes in order to minimize, as far as possible, the wearing of grooves in commutators. With a generator, in addition to wear resulting from mechanical abrasion, there is an electrolytic disintegration of the copper segments passing under the positive brushes, and of the negative brushes delivering current to the commutator. Hence, copper wears away more rapidly under the positive brushes than under the negative.

The proper brush position must be considered for each individual machine and it is the practice of manufacturers to either locate the correct running position permanently or where this is not practical, to furnish instructions covering the proper setting of the brushes. Brush position not only affects commutation, but is a factor in determining the voltage or speed characteristics. However, the brushes should be set for best commutation and

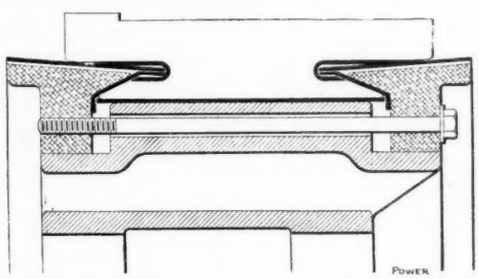


Fig. 2. Body-Bound Type of Commutator

any adjustment for voltage or other characteristics obtained by other means. The brushes of noncommutating-pole machines are generally given a definite "lead" from the neutral position, whereas those on commutating-pole machines are run on the neutral point.

During the past few years great strides have been made toward producing special grades of brushes for various conditions of service. It is impossible to make fixed rules governing the selection of brushes best suited for all cases, but a few comments regarding the characteristics of various grades of brushes, with some of their principal applications, may be of assistance to operators.

Compared with carbon, graphite brushes have a higher coefficient of friction, lower contact resistance, higher current capacity, less tendency to chatter, greater lubricating properties and ability to give better commutator polish. On account of their low contact resistance, graphite brushes can be used on very few high-voltage machines (500 volts and over) without producing sparking, while on nearly all low-voltage apparatus they usually give excellent results. It should be noted that graphite brushes

†Direct-Current Engineering Department, General Electric Co.

*From an article in the May issue of the "General Electric Review."

have very little abrasive material in their composition, hence they will not wear the mica rapidly enough to keep it even with the surface of the copper. For this reason it is common to slot the side mica to a depth of $\frac{1}{32}$ in. to $\frac{1}{16}$ in. below the surface, wherever graphite brushes are used. As an alternative, some dry-carbon brushes may be used to keep the mica worn down, the remaining graphite brushes acting as lubricators. Successful results have also been obtained by using graphite brushes with a small percentage of abrasive material in their composition, which serves to wear the mica more uniformly with the wear of the copper.

A given grade of brush will give the best results only when fitted in a properly designed brush-holder and it should be borne in mind that no brush-holder suitable for universal application has yet been made. The question of brush-holders is important as it is necessary to provide for free radial movement and at the same time arrange the brush supports so that there is a minimum tendency to bind or chatter. Frequently, a change from carbon to graphite brushes necessitates new brush-holders so arranged that the brushes will ride at a different angle and have an entirely different scheme of applying the pressure.

Machines fitted with graphite brushes have been known to develop severe sparking after operating for some time with excellent commutation. In such cases, investigation usually shows that as a result of the commutator polish gradually improving, the brush friction is reduced with a consequent change in the position which the brushes take in the holders. This in turn results in a tendency of the brush to ride on either its heel or toe, raising the opposite edge a very small amount away from the commutator; a short arc is set up under that portion of the brush, which is raised slightly from the commutator, and the heated particles are thrown out in the form of long yellow sparks. An increased brush pressure will frequently cure such trouble.

Cleanliness is always essential to best operating conditions, but, in cases where the atmosphere is filled with foreign substances which it is impossible to eliminate, the nature of the substance must be considered, and such treatment applied as will minimize its detrimental effects. For example, the same brush equipment or treatment might not be applicable to two duplicate machines, one installed in comparatively clean surroundings, such as the average railway substation, and the other at a coal mine or cement mill, where the air is filled with foreign matter. In the one case, brushes with slight lubrication would probably give the best results, while in the other, the use of any lubricant would have a tendency to collect the dust, and, in the event of such foreign matter being of a conducting or abrasive nature, poor commutation and destruction of both brush and commutator surfaces would undoubtedly follow. Under the latter condition dry-carbon brushes would probably be satisfactory if the machine were of a slow-speed type, but if operated at high speed, chattering might result, and about the only alternative would be the use of some form of graphite brushes, if commutation permits.

Successful methods of keeping machines clean may be outlined as follows: In a fairly clean station, with machines using carbon brushes, unless proper care is exercised an accumulation of foreign matter may appear on the commutator surface. This can be prevented by lubricating sparingly with a good grade of light engine oil and wiping off with a clean cloth. In steel mills, mines, etc., where the atmosphere may be full of conducting grit and the machines have graphite brushes, the commutators should be wiped frequently with a dry cloth and any accumulation of dirt removed from the brush rigging, as this is likely to fall on the commutators and be ground into the brushes. In such plants, screens should be placed so as to protect the apparatus from drafts and soot-laden air. For wiping commutators, such material as heavy canvas should be used, as the lint from waste or cheese cloth catches under the brushes and causes trouble.

Whenever brushes are replaced, the new ones should be carefully fitted to the commutator with sandpaper. To fit a set of brushes, the sandpaper should always be drawn in one direction, preferably the direction of rotation.

When the brushes wear down, sometimes the copper plating comes in contact with the commutator, causing burning. A new set should always be examined and any excess plating which may cover the wearing length should be removed. The purpose of the plating is to give better contact between the carbon and the pigtail terminal and to permit of a soldered connection, but it frequently extends too far toward the contact surface of the brush.

Brush pressure should be studied by the operating engineer to determine the degree which will give minimum friction and at the same time be sufficient to permit the brushes to ride properly on the commutator. Too high a pressure will result in excessive heating and sometimes causes the brushes to bind in the holders. Too little pressure will permit the brushes to change their position in the holders and chatter, thus causing sparking.

Oil is detrimental to mica and its accumulation on any part of the commutator should not be tolerated.

Numerous methods have been devised for truing commutators which have become badly grooved, rough or eccentric, and brief comments will be made on those most frequently employed.

Turning Tool

This consists of a simple tool post, for holding the cutting tool, mounted on suitable ways and fitted with a cross-feed screw. The tool must be mounted very rigidly to prevent chattering and a cutting speed of about 550 ft. per min. has been found best. Unless such a tool is operated by an expert, too much of the surface of the commutator may be turned off. Another objectionable feature is that there are but few commutators whose normal peripheral speed is as low as the tool-cutting speed required, and, therefore, the others will not have the same throw as will occur when under service conditions. Occasionally, a commutator is ground with a stone clamped in the tool post, but such a method is very slow and the tool is seldom sufficiently rigid to entirely remove "flats."

Sandpapering Block

This is a simple device consisting of sandpaper held in a wooden block, having approximately the same curvature as the commutator, and applied by hand or by means of a lever using the machine base as a fulcrum. Such a device is liable to aggravate flats and removes nearly as much material from between ridges as from their tops.

Grinding Tool

The grinding is accomplished by an excellent device, consisting of a rotating grinding wheel, so arranged that

it can be fed back and forth by means of a lead screw. The grinder must be rigidly supported to prevent vibration. The advantages of such a tool are that the minimum copper is removed, a perfect cylindrical surface is obtained, and the work may be done with the machine at full speed, where the commutator will have its normal "throw" or "swing," and will take its actual running position in the bearings. In cases of emergency, commutators have been ground with the machines actually operating on the line. The success of such a tool depends upon its being rigidly supported and having closely fitting bearings, so that there is no vibration of the grinding wheel. The latter must be of such composition as will not wear away too rapidly or clog with copper.

Whenever any truing device is being used, all windings should be protected from copper dust, and the brushes should be raised to prevent their being coated with copper on the contact surfaces. Such protection is further assured by the use of a grinding tool provided with a wheel shroud and exhauster with bag attachment for collecting the dust.

A light application of fine sandpaper held in the hand will give a much improved surface after turning or grinding. Before bringing the machine up to voltage the segment insulation must be gone over carefully and any evidence of copper bridges from bar to bar removed. Slotted commutators should have the slots cleaned out with a hacksaw blade and the edges slightly beveled or rounded. The machine should then be blown out and all accessible parts cleaned thoroughly, followed by a final wiping of the holders and brushes, before being put in service.

In the long run, close attention to everyday duties counts more than anything else toward keeping the electrical apparatus of a plant in prime condition. If the brushes chatter and spark it is probably due to high mica, rough commutator or incorrect angle of the brushes. When commutators are true and smooth, but show black bars, this is an indication of poorly soldered joints in the armature winding or equalizer connections, or possibly an insufficient number of equalizer rings.

CORRESPONDENCE

Recharging Dry Batteries

In answer to Mr. King's letter in the Apr. 8 issue, stating that his dry batteries did not respond to the treatment prescribed by Mr. McGerry, I think the latter is mistaken in claiming that dry batteries can be recharged with current from an outside source. He says to melt a hole in the wax and let them be submerged in water for a few minutes then seal them up again before charging. The result which he gets is not due to the charging process described, but is due wholly to letting them stand in water. If he will take an old battery and dissect it, he will find next to the zinc that there are several layers of blotting paper, then the contents of the battery, which is composed of some absorbent material, such as carbon, manganese dioxide or graphite, with the carbon rod in the center. This has the binding post attached when the batteries are assembled. The mixture used for filling is thoroughly saturated with sal ammoniac or other chemicals, after which the zinc tube is sealed with pitch or wax.

The battery loses its strength, due to the gradual drying out of the solution used to moisten the contents, and can sometimes be revived by melting the wax and saturating the contents with water, sal ammoniac or salt water, then resealing. Provided the zinc is not corroded too badly the batteries will last some time and show very good results.

Another way is to take off the pasteboard cover and puncture the zinc with six or eight holes then set the battery in a can of water and let it remain there for door-bell or telephone service, care being taken to keep the cans full of water and see that they do not touch.

LEON L. POLLARD.

Fairfield, Maine.

Oil Throwing

When out on trouble work some time ago I came across two unusual cases of oil throwing which may be of interest to readers of POWER.

The first occurred in connection with a 500-kw. direct-current traction generator which was coupled direct to a high-speed, vertical, triple-expansion engine running at 150 lb. pressure and high superheat with the usual pressure-lubricating system.

Oil was found to accumulate at the back of the commutator and when the set was running this oil was thrown about. It was easily proved that the oil did not come from the dynamo bearing and a flywheel between the engine and the dynamo precluded any possibility of oil coming from that source.

The trouble was finally traced to the stuffing-box on the high-pressure cylinder. A certain amount of oil leaked through here and this became vaporized and was carried by the draft through the armature spider and condensed on the comparatively cool surfaces behind the commutator. A small amount of steam and water also leaked through from the high-pressure cylinder and this became mixed with the oil and thus helped in the condensation. The trouble was overcome by completely inclosing the piston rod with sheet metal.

The other trouble occurred on the middle bearing of a 500-kw. motor-generator set.

The oil in this case leaked out of the ends of the bearing just as if it were overfilled and the drops were carried by windage onto the stator windings of the motor. It was again proved that the oil was not creeping along the shaft. Various kinds of oil were tried without lessening the trouble, which was eventually found to be caused by the oil ring throwing oil onto the inside of the bearing cap, whence it ran down to the joint between the top and bottom halves of the bearing shell and was then carried along the joint by a kind of pumping action due to vibration.

It was not found possible to eliminate all of the vibration and the remedy applied was the fitting of a sheet-metal lining to the inside of the bearing cap and extending this to overlap the joint to prevent the oil reaching it.

The remedy is simple and quite effective. I have since seen it applied in several instances where all attempts at improving the lining up of machines had failed.

Schenectady, N. Y. N. M. HILL.

GAS POWER DEPARTMENT

Gas-Engine Sounds

By A. L. Brennan, Jr.

Practically all contingencies which arise during the operation of a gas engine are manifest in one way or another by some form of sound, and if one will pay strict attention to these noises and note their indications he will become conversant with an internal-combustion motor in a way that will prove of great benefit. Gas-engine sounds can be divided into two general groups, as follows:

Group 1. The sounds produced by the normal operation of the motor; these include the roar at carburetor, the click of valves, roar of gears and other rhythmic sounds, which are easily recognized.

Group 2. Unusual noises, which are in many cases symptons of trouble, may be subdivided into five parts:

1. Knocking—mechanical or functional.
2. Pounding—mechanical.
3. Squeaking—lack of efficient lubrication.
4. Hissing or puffing—gas under pressure escaping.
5. Numerous irregular puffs and pops.

Knocking is invariably produced within the cylinder and acquires the form of a regular and continuous tapping which is quite distinct and easily recognized as not being a sound generated by normal operation. Experience in operating gas engines will be of great help in determining this special sound, but not altogether necessary as it is one of the easiest to recognize.

Functional knocking can be attributed to a faulty mixture, early ignition or preignition from incandescent carbon deposits. If due to a faulty mixture, this will invariably be found too rich, and when ignited it burns either too quickly or too slowly, usually the latter. In some cases this form of knocking results from allowing the engine too much gas of a correctly proportioned mixture, thus interfering with ready combustion and partly preventing the cylinders from clearing themselves of the burnt gas; this is commonly referred to as "choking up."

When the spark is responsible for knocking, it is invariably because of too early ignition, the explosion taking place before the compression stroke is completed, thus a heavy rapid force is exerted on the piston before dead center has been passed. Incandescent carbon deposits often bring about a similar occurrence by igniting the fresh gas as it is undergoing compression; the symptoms in this case are almost identical with those of the former. Hence, if a knock becomes apparent within the cylinder, the trouble usually may be remedied by retarding the spark, reducing the amount of gas allowed the engine or making the mixture leaner. In regard to over-rich mixtures there are several symptoms, apart from knocking, which indicate this condition, namely, the engine firing regularly but weak, and other symptoms which will be learned with slight experience.

If, on retarding the spark, changing the quality of the mixture and the amount thereof, the knocking does not abate, it is evidently due to carbon deposits. Sometimes carbon deposits have no effect on a motor at normal speed, but when operating at high speeds, which tends toward overheating, especially in cases where considerable gas is allowed and the spark is retarded, the carbon deposits will become incandescent and preignition will result.

The knocking attributed to the foregoing causes is in some instances so severe that they resemble a heavy pound, but varying to a considerable extent, according to the type of motor; in small high-speed engines the sound is slightly sharper and more distinct than in heavy slow-speed motors.

Other knocks peculiar to the cylinder can be attributed to loose or worn bearings, or to any parts of the piston, rings, wristpin, connecting-rod, or cylinder having mechanical lag or play. Except in extreme cases, however, knocking produced by any of these causes will not be so severe as that previously mentioned. To an inexperienced operator, knocks which are not directly allied to the cylinder will seem to originate at that point. Troubles of this order can be traced by placing one end of a hammer or other tool against the motor and resting an ear on the other end.

Loose or badly worn crankshaft bearings will cause heavy pounding.

Squeaking is more often a sign of inefficient lubrication than insufficient lubrication, as is generally supposed. If neglected it will eventually lead to overheating, rapid wear and probably knocking.

Hissing and puffing sounds which in some cases resemble wheezing often may be traced to a faulty piston or to a cylinder worn oval. Poor lubrication in the cylinder will bring about rapid wear of the rubbing surfaces resulting in this condition, which indicates the loss of gas while under compression and during the power stroke. This, of course, diminishes the efficiency of the motor. Any misalignment of the piston pin, connecting-rod or crank throw will induce this kind of wear in the cylinders.

Other hissing sounds can be traced to faulty gaskets, loose spark plugs or igniters, inlet or exhaust valves not seating properly, loose exhaust manifold or unions on the exhaust pipe. These are not all the unusual sounds and their indications found in a gas engine, but are sufficient to help the average operator in speedily locating trouble.

Having considered sounds in a general way, means of preventing these troubles will now be taken up. In many instances the cause for a mechanical knock is the same as that which produces a functional knock, namely, faulty lubrication, by allowing wear in the first place, and carbon deposits in the second. The prevention is to use suitable quantities of cylinder oil of good quality, high flash point and proper viscosity. It must be born in mind that this condition is only approximated, that is, no matter how careful an operator is in maintaining a correctly proportioned mixture in conjunction with well regulated lubrication, carbon deposits will be constantly forming,

but they will be so slight as to prove in no way detrimental.

On some motors the oil supplied for lubrication between the cylinder walls and piston is also called upon to lubricate the wristpin. Therefore, an oil that does not undergo much change when subjected to the high temperatures of the cylinder must be used. Oil that is easily burned or which gums up will not perform this function well and it will be but a comparatively short time when the piston rings will become so gummed up as to render the lubrication of the wristpin inadequate, resulting in wear and finally a knock, which will rapidly grow worse.

Motors employing the splash-feed system of lubrication are prone to carbon deposits, due to excess oil being thrown up at times; this, in turn, is usually traceable to an over supply in the crank case. This is easily avoided by adding small amounts of oil to the crank-case supply at frequent intervals instead of greater amounts at longer intervals.

Excessive lubrication of good oil is quite as harmful in the long run as poorer oils fed in about the correct proportions. Viscosity has a great deal to do with proper oiling or, in lubricating other parts, with various mediums, such as hard grease, graphite, etc. Therefore, although an oil might have a high flash point, it may still be unsuitable for cylinder lubrication.

Any mechanical features which show signs of looseness should receive prompt attention. By looking after troubles of this nature at once little difficulty will be experienced in maintaining efficient operation.

Obviously, mechanical depreciation of a mechanism cannot be altogether overcome. This holds true especially of internal-combustion engines, due to the fact that they operate under variable conditions, which, in some cases, are very exacting. It is well to remember, however, that a gas engine will generally give warning of approaching trouble in time to prevent any particular harm.

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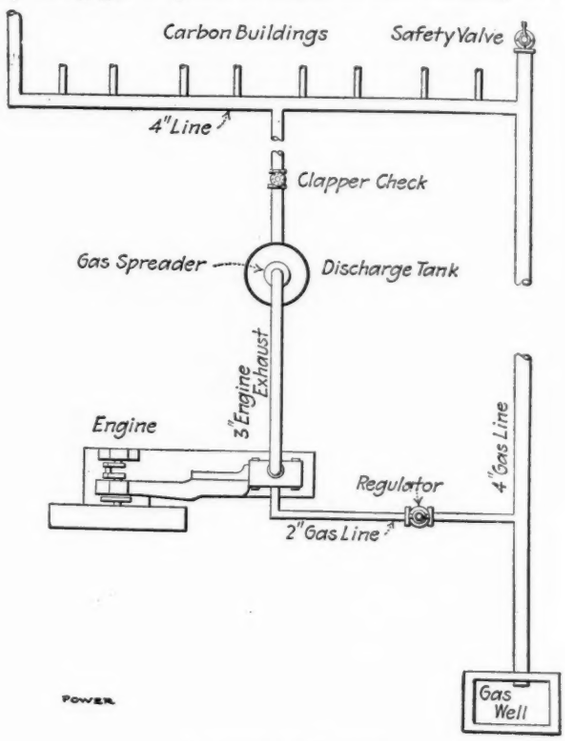
Utilizing Initial Gas Pressure

A somewhat novel method of power generation is employed at the Wilsonburg, W. Va., plant of the Union Gas & Carbon Co., manufacturer of carbon black. This product is the hydrocarbon extracted from the flame of natural gas by impinging it on a smooth surface and then removing the deposit by means of steel scrapers. The carbon black is used extensively in the manufacture of printing ink and paints.

The natural gas is supplied from a well 3000 ft. deep and at a pressure of 950 lb. Formerly this was led through a 4-in. main direct to the carbon buildings and the power necessary for driving the scrapers, etc., was obtained from a steam boiler and engine.

The management, however, conceived the idea of utilizing the initial pressure of the gas by passing it through the cylinders of the steam engine, the latter serving in the capacity of a reducing valve and, at the same time, doing away with the use of steam. Accordingly, the piping was arranged as shown in the sketch, a 2-in. branch being taken off the 4-in. gas main and led through a regulating valve to the engine. The exhaust is led into a discharge tank, a spreader being provided at the end of the exhaust pipe. From the discharge tank the gas passes through a 3-in. main to a clapper check valve, which works simultaneously with each chug of the exhaust and allows the gas to feed into the carbon buildings with constant regularity.

By using gas in place of steam in this manner, the engine is said to respond quicker and more uniformly. It also, not only provides free power, but reduces the labor by one man.



LAYOUT OF PIPING

CORRESPONDENCE

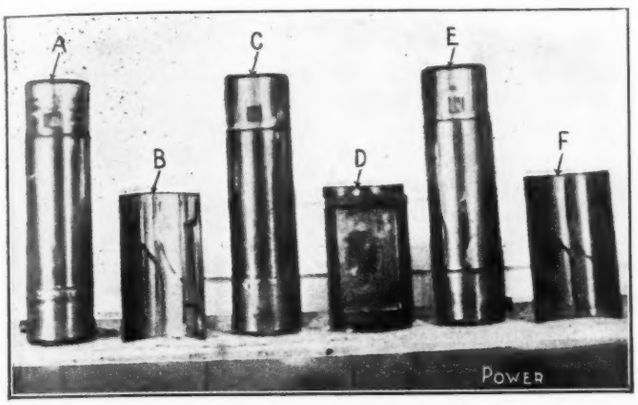
Results of Good Lubrication

In our power plant, consisting of four vertical Westinghouse gas engines, we recently overhauled two, cleaning the pistons and putting in new rings, also renewing the piston pins, lower crosshead brasses, wedges and wedge bolts.

The engines have been in service in an office building eleven years where power is required day and night. These two engines have had new piston rings four times during that period; but this was the first time that any of the pins or brasses have been renewed. When the pins and brasses were taken out it was found that they would have been good for a number of years more service. The pins showed hardly any wear, the lower brasses showed only slight wear, while the top brasses were apparently as good as new and were put back again. The only parts showing wear were the threads on the wedge bolts and in the wedges, some being worn nearly to the point of stripping; but as they receive the hardest strain of any of the parts it was expected that they would be badly worn.

The accompanying illustration shows a set of pins and brasses from one of the engines. The first *A* shows the working side of one of the piston pins; *B* is one of the

lower crosshead brasses still containing good, deep oil grooves; *C* is a side view of a pin, the working side to the left and the idle or top side on the right; *D* is a bottom view of one of the brasses, showing very little wear of the wedge, also showing that the wedge was only about half way up; *E* shows the idle side of a pin; and, *F* one of the brasses just as it was taken out of the engine



BEARINGS AND PINS AFTER REMOVAL

without being cleaned, showing the oil grooves nearly filled with carbon, which is common in gas-engine bearings.

We have credited the good wearing qualities of our bearings to our careful and special method of lubrication.

L. M. JOHNSON.

Emsworth, Penn.

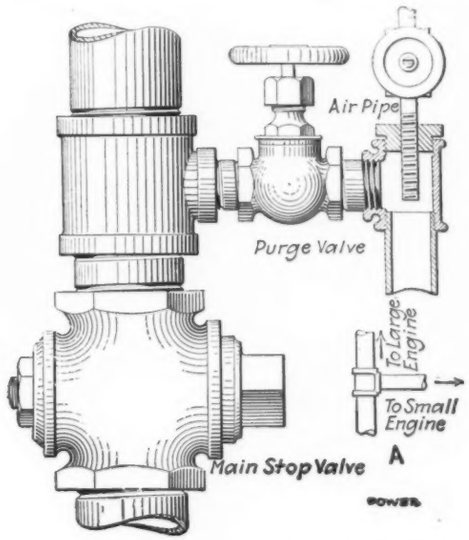
Difficulty in Starting a Gas Engine

Some time ago I had charge of a plant containing two gas engines running on suction-producer gas. One was a 16-in., two-cylinder, vertical running at 250 r.p.m., and the other a 14-in., single-cylinder, horizontal machine running at 180 r.p.m. The latter was run morning and evening for about two hours each when the load was heavy. The two engines ran off the one producer, the connections being as shown at *A* in the sketch.

Upon starting the smaller engine the larger would not let it get the gas, since it ran faster, was larger and was situated nearer the producer. As soon as the small engine was given a few shots of air to get it in motion and the gas valve was opened, the air would rush in, caused by the suction of the other engine, and draw the gas away from it. I tried getting the small engine in motion with compressed air and have someone throw in the friction clutch on the lineshaft to pull it up to speed; then open the gas valve. Then the engine would suck the gas until it came to the cylinder, when it would start to take explosions and commence working in parallel with the other engine. The small engine was driving a lineshaft on the other side of the yard from the large engine, the two shafts being connected by a long belt with about 75 ft. between centers.

This proved to be an inefficient method of starting, however, as it not only pulled down the speed of the shaft, but burned the hard-wood blocks in the friction clutch and caused no end of trouble. After trying different methods, I finally succeeded in making a device which proved successful and which may help someone else who has two engines running under such conditions.

There was a 1¼-in. nipple and valve in the gas pipe just above the main stop valve to be used as a purge pipe. Into this valve I screwed a nipple and tee. I then put a bushing on the one side of the tee and a 1¼-in. nipple 6 in. long on the other side. Into the bushing I screwed



SCHEME FOR SUCKING GAS TO ENGINE

a ⅜-in. pipe so that its lower end extended below the center of the tee, the other end being connected with the air tank.

For starting I opened the valve on the purge pipe and then opened the small valve on the air pipe, this acted as a siphon and drew the gas to the engine. After giving the engine a few shots of air at 150 lb. to get it in motion, I opened the gas valve to the engine, closed the 1¼-in. valve and shut off the air. The engine would then continue to draw the gas.

HARRY WESTWOOD.

Stratford, Ont.

Binders for Fuel Briquettes

Experience in European countries and investigations made at the fuel-testing plant of the United States Geological Survey at St. Louis, and later by the Bureau of Mines at Pittsburg, have shown that lignite may be successfully briquetted without the use of any additional binding material, and that the most satisfactory binders for anthracite, semi-anthracite, bituminous and subbituminous coals are coal-tar pitch, gas-tar pitch and asphaltic pitch.

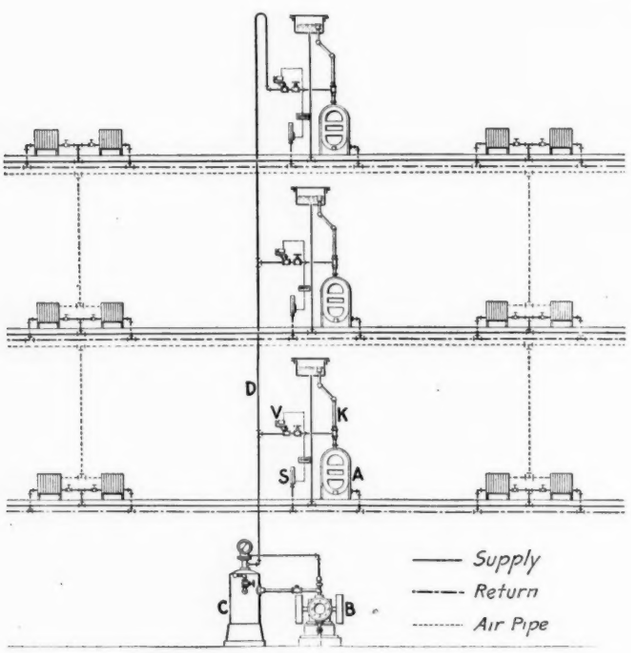
Of the 19 briquetting plants in commercial operation in the United States during 1912, 10 used as a binder coal-tar pitch, or mixtures in which it is the chief ingredient; one plant used asphaltic pitch, two used water-gas pitch; four used mixed binders whose composition is not made public, and two (one operating on peat and the other on carbon residue) used no binder.

Inorganic binders, such as cement, have not given satisfactory results, for, although they may form efficient binders they have the serious objection of increasing the ash and adding nothing to the combustible elements of the fuel.

HEATING AND VENTILATION

Compressed Air to Circulate Hot Water

In the isue of Apr. 15, a short note concerning the introduction of compressed air into the riser of a hot-water heating system was published. Since that date additional information has come to hand. An illustration of the system designed by Herman Kraus, engineer of the German Musuem in Munich, is shown herewith. The compressed air is introduced into a riser leading directly from the heater, or hot-water boiler to the expansion tank, where the air escapes and the water is returned through the radiators to the heaters. The supply of air may be controlled by the outside temperature or, as shown



KRAUS HOT-WATER SYSTEM USING COMPRESSED AIR

in the drawing, by the temperature of the return. A thermostat is connected with the return and controls a pressure-reducing valve on the air supply.

The compressed air is supplied by an electrically-driven compressor which is automatically controlled according to the presure in the air tank. From the tank, the air passes through the reducing valve and enters the riser through a specially designed nozzle.

In the sketch A represents the hot-water heater, B the air compressor, C the air tank, D the air-pressure piping, V the reducing valve, and S the thermostat. It may be noticed that an expansion tank E, and a hot-water heater are shown on each floor. From each expansion tank there is a connection to atmosphere so that air may escape without having the oportunity to enter the radiators and interfere with the operation.

In the state sanitarium at Hütteldorf, Vienna, ten large buildings are equipped with this system. The installations were made five years ago, and according to reports have given excellent satisfaction. Some of the advantages claimed by the inventor are adjustment of the rate of flow according to the outside temperature or to the temperature of the return, the possibility of obtaining the necessary amount of compressed air for a full day inside of one or two hours, central regulation, no possibility of overheating the water in the system and the use of pipes of small diameter.

Any hot-water heating system can be fitted up with the air equipment at small cost. The system is recommended especially for green houses where uniform and high temperature is essential.

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Hot-Water Direct-Heating Charts

BY FRANK B. GILBERT, JR.

Various methods are used in computing the amount of radiation required for heating, although the heat unit is the most satisfactory basis. The relations commonly used are expressed by the formula

$$Sq.ft.\ rad. = \frac{E \times C \times D}{F}$$

where

E = Square feet of exposed building surface;
C = Coefficient of heat transmission = B.t.u. transmitted per hr. per sq.ft. per deg. difference in temperature;
D = Difference in temperature;
F = Radiator factor = B.t.u. radiated per hr. per sq.ft. radiator surface.

Application of the formula is simplified by using the accompanying charts, the design of which includes the following values of the coefficient of transmission C.

	C
Skylight (single glass)	1 12
Slate roof	1 10
Window (single glass)	1 00
Shingle roof	0 90
Corrugated iron wall	0 84
4-in. brick wall	0 68
Skylight (double glass)	0 62
8-in. brick wall	0 46
Wooden door	0 42
12-in. brick wall	0 33
Wooden wall	0 28
Wood and composition roof	0 28
16-in. brick wall	0 27
20-in. brick wall	0 23
24-in. brick wall	0 20
Wooden ceiling	0 104
Wooden floor	0 08

The value of F is taken at 150, which holds for the usual hot-water system operating under ordinary conditions. East, west and north exposed surfaces are considered as losing 10, 20 and 30 per cent., respectively, more heat than a wall of south exposure.

Illustrations of the use of the charts are shown by the dotted line on which arrows indicate the order in which the several sets of curves are to be taken. In Fig. 1 the problem illustrated by the dotted line is to determine the

amount of radiation necessary to supply heat radiated to out-of-doors by 3000 sq.ft. of 12-in. brick wall with a west exposure and a temperature difference of 80 deg.

Starting at the 3000 division of the scale for square feet of exposed building surface located along the right-hand edge of the chart, the line of reading would follow to the left until intersecting the line representing a 12-in. brick wall. From this point of intersection follow vertically to the line of 80 deg. temperature difference, thence horizontally to the line indicating west exposure and vertically to the scale of required radiation, which gives a reading of 630 sq.ft.

The proportioning of the amount of radiation necessary to heat incoming air is largely a matter of experience in assuming the number of times per hour the total air contents of the building will be changed. This factor varies for different types of construction and depends also on the probable frequency with which doors and windows will be opened. For an average value, one air change per hour for ordinary factory buildings is consistent. For residences, two air changes per hour on the first floor, one and one-half on intermediate floors, and one on the top floor may be used.

Fig. 2 gives graphical solutions to problems involving

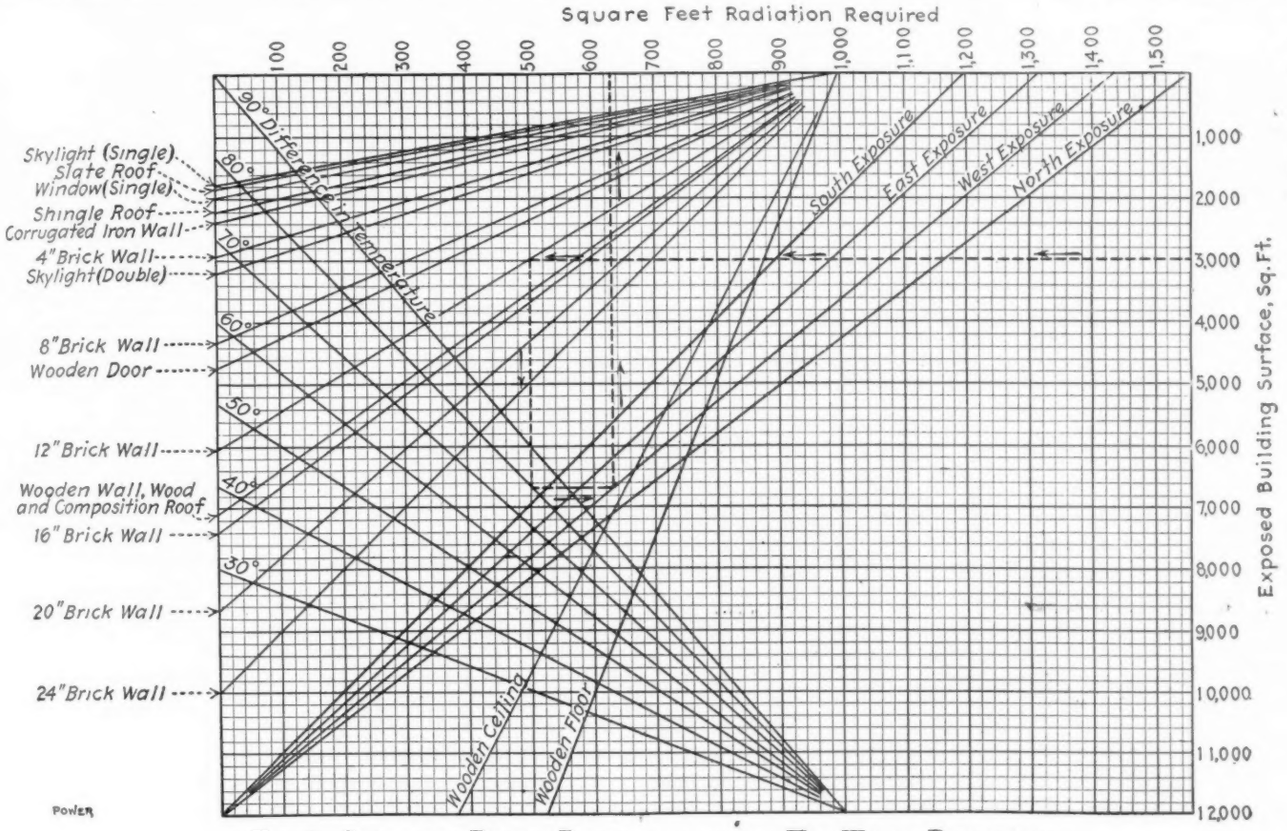


FIG. 1. CHART FOR DIRECT DETERMINATION OF HOT-WATER RADIATION

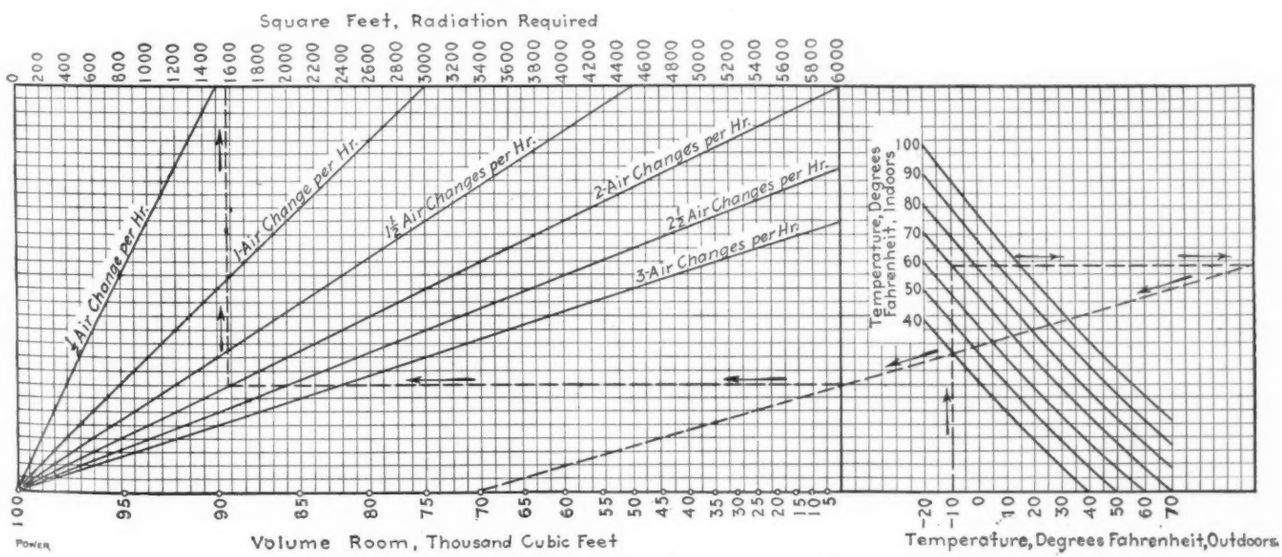


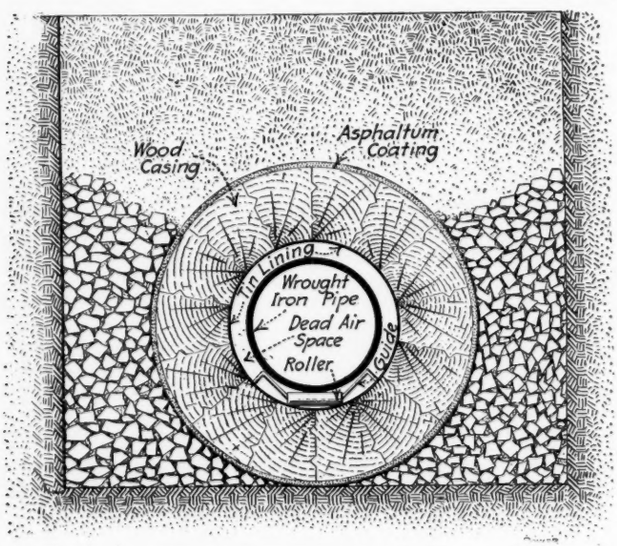
FIG. 2. HOT-WATER RADIATION REQUIRED FOR AIR CHANGE

the changing of air contents. The case illustrated by the dotted line is for a room of 70,000 cu.ft. in volume heated to 70 deg. with an outdoor temperature of 10 deg. below zero and assuming two changes of air per hour.

Beginning, as indicated by the arrows, at the scale of outdoor temperatures, rising to the curves for 70-deg. indoor temperature and horizontally to the right a halt is made at the vertical line on the extreme right-hand side of the chart. A straight-edge is placed to coincide with this last position and the point marked 70,000 cu.ft. volume of room. On the vertical line immediately to the left of the temperature curves the straight-edge locates a point from which a path is followed horizontally to the left until intersection is made with the line representing two air changes per hour. From this intersection vertically to the scale at the top of the chart gives a reading of 1570 sq.ft. of radiation necessary to heat the incoming air.

Wooden Pipes and Casings

In the olden days, wooden pipes were the standard water main. Common pump logs with the bark on were used. In some cases the lasting qualities of these logs were remarkable. In 1613, London laid 400 miles of elm logs, and in 1862 some of them were removed in good condition after being down 249 years. Detroit had 100 miles of these pump logs and they have been in use in various other states in the Union. The ordinary log,



SECTION THROUGH UNDERGROUND STEAM MAIN

however, would not stand much pressure. For the high pressures now employed it was necessary to reinforce the pipe with iron banding. A better joint was required and a coating which would make the exterior impervious to moisture. Since 1869, the Michigan Pipe Co., of Bay City, Mich., have been working on these points and have evolved a wooden pipe which will withstand a water pressure of 200 lb. per sq.in. For the exacting requirements of steam heating a modification of the above pipe has been adapted as a casing to surround the underground piping of the system. The larger casings are made up in 6-, 7- and 8-ft. sections of white pine or Michigan tamarack staves, which are dressed on the edges to conform to a circle and are fitted with a tongue and groove the full length. The staves are banded together with galvanized wire. A mortise is put in one end, and a tenon on the other, so the sections can be driven together. In the coating rolls the outside surface is covered with a thick layer of hot liquid asphaltum. The pipe is then rolled in sawdust, given a second coating of asphaltum and rolled again in the sawdust.

A shell 4 in. thick is considered standard, although 3- and 2-in. shells are used in some cases. In a certain test on underground steam pipe surrounded by a 4-in. casing a loss of steam of only 0.038 lb. per lb. per sq.ft. of pipe surface was reported. When this is compared to 0.840 for bare pipe with a temperature difference of 280 deg. between the air and steam, the insulating qualities of the casing will be better appreciated.

Pipe Sizes for Forced Hot-Water Heating

Answering Mr. Kent's question, in the Apr. 29 issue, regarding the method of determining the total friction head in order to use the tables for pipe sizes given by the writer in the Apr. 1 issue, I desire first to call attention to a confusion in the wording of the first sentence at the top of the second column. The meaning is evident, but the following sentence relieves any doubt: A more logical method would be to fix the total friction head and from the total length of the system determine the allowable friction head per 100 ft.

To determine the most economical relation between size of piping and size of pump a modification of Lord Kelvin's rule for the most economical section of an electric conductor may be used. His rule is that, "The annual interest on capital outlay should be equal to the annual cost of energy wasted." For forced hot-water work the interest and depreciation on the cost of the piping and covering plus the cost of the loss due to radiation should equal the interest and depreciation on the cost of the pump plus the cost of pumping the water.

If different total friction heads are assumed and the size of pipes for each head determined by the table mentioned above, and the various interest and cost charges computed, two curves can be plotted. The ordinates should be "dollars" and the abscissas "total friction head." One curve is plotted between friction head and the interest and loss charges for the piping system. The other curve is plotted between friction head and total interest and cost on pumping the water. Where they cross will be the friction head to use.

This method may, however, be found to be too long and complicated, and fairly close results may be obtained by assuming the total friction head. For the smaller installations a friction head of 35 to 40 ft. is used, running up to 80 ft. with the largest single installations or a small group of moderate-size buildings. For large installations where there are a large number of buildings or the circuits are very long the friction heads run up to 120 ft.

In the example given by Mr. Kent no length is stated, but suppose the total run is 3000 ft., and assume a friction head of 60 ft. This will give a friction head of 2 ft. per 100 ft. of length. Then from the table it is found that the main should be 4½ in., the branch with 1200 ft. 2 in. and the branch with 400 ft. 1¼ in.

Brooklyn, N. Y. W. L. DURAND.

EDITORIALS

Discrimination

In an effort to justify its charges an electric company will certify to a public-service commission that it costs between four and five cents per kilowatt-hour to make, distribute and collect for current.

And then the same company will take a contract to sell the current which costs four or five cents for a cent or under.

Well, who is any the worse off?

The customer gets his current cheaper than he could make it, the small consumer pays no more than he would otherwise, and the electric company gets a considerable increase to its income at a comparatively small increase in expense.

But the same reasoning carried to its logical conclusion would lead into broad fields of discrimination. Imagine a manufacturer of some product of the delivered cost of which the freight is so large a factor that he could not run his factory or work his mine or quarry where it happens to be located and pay the regular schedule freight rates. Railroad trains pass his door in numbers every day. It would cost the railroad very little additional to hitch his car onto one of these trains and haul it to his market. If it were so hauled at a price considerably more than this additional cost, the industry would be kept alive, the manufacturer and his employees be furnished with profitable occupation, the users would enjoy the benefit of the greater supply and the railroad would make money, while those who paid the regular rate would pay no more than they had been paying.

But this would be discrimination and would not be tolerated. To allow it would be to put into the hands of the railroad power to ruin not only individuals but industries and towns.

A gas company cannot sell the same gas at one price for lighting and at another for heating, nor in many states is it allowed even to give large consumers an advantage in the rate. How far are the courts and the public-service commissions going to allow the electric companies to go with this kind of discrimination? This is one of the most weighty and interesting questions in the power-plant field.

In the last analysis, from a social-economical point of view the question of the displacement of the isolated plant by central-station service ought to be settled upon the broad engineering consideration of ultimate cost. How can the service be rendered most efficiently?

If the problem of operating the varied industries of a large city at the least cost and at the best efficiency were submitted to a competent engineer, he would, in our opinion, neither put in an immense central station nor continue the numerous makeshift, uneconomical, separate installations for each several building or industry, but by grouping the plants of city blocks or neighborhoods would evolve a lot of good-sized efficient plants with favorable load factors, important enough to warrant the employment of good engineers, and capable of furnishing heat as well as light and power. Such a block plant, when a considerable proportion of the exhaust steam can be used for heating, etc., will produce and deliver light, heat and power cheaper than any central station can do so at a profit upon any reasonable basis of competition.

Selection of Men and Equipment

Asked the source of greatest trouble in their large plants, several chief engineers have replied that labor troubles headed the list. These troubles, the cause of which may be traced directly to the labor, are not brought about through strikes, unions or dissatisfaction over wages, etc. They are the result of incompetent or neglectful workmen performing duties requiring skill, unceasing vigilance and strict attentiveness.

And here, as far as the chief engineer is concerned, lies the great difference between men and equipment. If a new turbine, condenser, boiler or stoker is needed, the selection of the best, or the best for the particular plant, is not such an exceedingly difficult matter. Books have been written, tests conducted, voluminous data compiled —all to assist in determining what kind, type or make of unit is best for any particular purpose.

Not so with men. They may bring references and diplomas galore, but these are not always a true indication of how well the men will perform the duties they are hired to perform.

The labor, skilled and unskilled, that the average chief engineer hires, is to him much like an apparatus the worth of which cannot be definitely determined without trial.

It behooves every man to be as good as he says he is and better than his employer thinks he is.

To Men in Charge of Auxiliaries

In large plants the chief or assistant chief engineer cannot constantly watch every piece of apparatus. The assistant engineers are usually too busy in the engine room to make frequent inspection trips through the cellars, pump rooms, etc. They must, therefore, depend much upon the men in charge of auxiliaries to perform their duties well without being watched over.

It is only after an oiler, helper, pumpman, coal conveyor operator, etc., has assumed the responsibilities of engineer that he can fully appreciate how valuable a careful and honest oiler or helper is. To feel that you have a man on watch with you who is giving all the assistance that he can, and in whom you have confidence, is indeed a factor that lightens the burden and worries of the working day.

Little oversights and things of which you say, "Oh, I forgot" become a regular occurrence through repetition.

It requires only reasonable attention to stop the coal conveyor when the last car or wagon has been unloaded. To run it longer unnecessarily uses power and wears out

the machine long before it should go to the junk pile. And the vacuum cleaner; there is no reason why it should be left running after the porter has sent word that the cleaning is finished. Neither should the cleaning of the oil and water filters and oil pipes be left undone until the engineer discovers that the boilers are scaled or the bearings are hot or destroyed. Nor should cleaning the boilers of soot be neglected until the firemen complain that they cannot "hold the steam."

Anyone assigned to a particular part of the plant should by all means make that part show that it is being well cared for. If little things go wrong they should be fixed without the formalities of a report. If the nature of a trouble indicates that something serious may happen if repairs are delayed, that should be reported at once. If one waits for the engineer to come and find the trouble it may be too late to avoid a shutdown.

❖

Catalog Distribution

Often a manufacturer will expend considerable effort and money in the preparation of a high-grade catalog or handbook only to defeat his own ends by the overcautious manner in which he restricts its distribution. That this is so was shown by an incident that happened in a large university of the Middle West. A student asked the instructor if the ——— pump was the only good one on the market. He was at work on the problem of designing a power plant and the ——— Pump Co.'s catalog, containing full data on the pumps put out by that company, was the only one found in the classroom library, although the instructor had made repeated efforts to secure catalogs or, at least, some general data on pumps of a variety of makes.

It seems that an inquiry from any but an obviously good prospect for a sale is often treated with slight attention. This is surely short-sighted.

The main function of a catalog or handbook is to predispose the reader to favor articles of a certain manufacture. And this predisposition cannot be developed too soon. What is more natural than for a student to go out into business life with a preference for the make of pump he specified for his first, although imaginary, power plant? Both sentiment and familiarity cause him to lean in that direction. These likewise cause him to prefer a certain type or make of chimney, boiler, stoker, heater, engine, dynamo, etc., right down the line.

It may be true in a certain measure that, as Emerson said, the world will beat a path to the door of the chap who makes a superlative mouse trap or other product, even though he locate his factory in the heart of the backwoods. However, the beating process is usually insuperably long unless accelerated by these modern highly developed road-making machines, advertising and salesmanship, both of which are but specialized modes of disseminating information.

The discerning manufacturer realizes this, for he scatters the seeds of information broadcast. To him it mattereth not if some few do fall by the wayside, some on barren ground and some, perhaps, among thorns. He knows that these lost ones cannot be less fruitful than if left to grow antiquated in the vault or storeroom so that they finally have to be thrown away as no longer suitable for distribution.

Safety Valve Rating

An interesting book on the above subject is reviewed on page 727. Safety valves have always been a prolific source of discussion and numerous rules are in effect governing their size. In all, the results are expressed in valve area, which is the area of the disk exposed to the steam pressure when the valve is closed. The rule in use by the United States Board of Supervising Inspectors of Steam Vessels assumes a lift of the disk equal to one-thirty-second of the valve diameter, and the Massachusetts rule assumes that the orifice opening shall be one-eleventh of the boiler-connection area, which for bevel-seated valves would fix the vertical lift of the disk at about one-thirty-first of the diameter. In either case the lift is supposed to increase with the size of the valve. As a matter of fact, it has been shown that safety valves do not lift in proportion to their diameters. The lift is practically the same for all sizes and smaller if anything for the larger valves.

Both rules are based on Napier's approximate formula for the flow of steam through an orifice, and maximum grate areas, for which each commercial size of valve may be used, enter into the question. Apparently the above assumptions will allow variation, but factors of safety introduced in each case insure a valve of ample size. Even if the various sizes of valve did not have the same lift, the formula could be reduced to a simple expression involving the diameter rather than the area, such as the one proposed in this paper some four years ago and mentioned in the review already referred to.

Dividing the weight of steam to be delivered per hour by the absolute pressure is simple. Then, with a constant of one-tenth, derived by fixing the lift at a certain definite height for all sizes, shifting the decimal point one place to the left gives the diameter directly. This is the dimension that is always required, but with the present rules further computation or reference is necessary to derive the diameter from the area.

To make a valve lift in proportion to the diameter is possible. If it is desired a modification of the above simple formula would answer and it might be made to include some allowance for higher lifts at low pressure and *vice versa*. This would mean complication, and after all safety and simplicity are the considerations of paramount importance.

As stated in our editorial in the Mar. 9, 1909, issue, the purpose of a rule for safety valves is not to determine with mathematical precision the exact area required to discharge a given amount of steam per second, but to indicate a size of valve which will be ample for that service without being so large as to discharge the boiler too quickly or to be extravagant in cost. The proposed rule will indicate such a valve in terms of the diameter. It is simpler and safer than the present rules, as above certain limits it specifies valves a trifle larger, which will readily discharge the assumed amount of steam in a given time.

Due to lack of space it was impossible to give the full context of the author's arguments in the review. It will be found worth while to read the book, and as the subject of boiler safety is all important, we will be glad to receive discussion or comment on the points raised by the author.

READERS WITH SOMETHING TO SAY

Simplified Formulas

Two rules or formulas for finding the capacity of tank in U. S. gallons and for finding the heating surfaces of boiler tubes are given below, which are, I think, more easily worked than the rules given in the Engineers' Study Course, as they are worked out by multiplication, no division being necessary.

Rule: *To find the capacity of a cylindrical tank in U. S. gallons, square the diameter in inches, multiply by the length or height in inches and multiply the product by the constant 0.0034.*

Formula $D^2 \times H \times 0.0034 =$ *capacity*

Proof $0.7854 \div 231 = 0.0034$ *the constant*

Rule: *To find the heating surface of boiler tubes, multiply the diameter of the tubes in inches by their length in feet and that product by the constant 0.2618.*

Formula $D \times L \times 0.2618 =$ *heating surface*

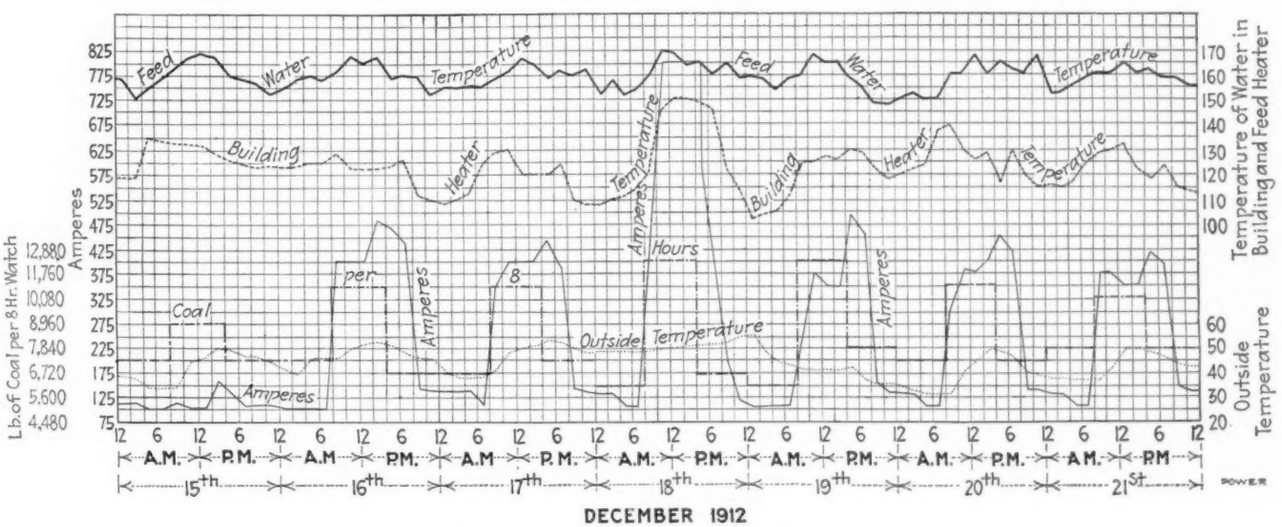
Proof 3.1416 *cir.* $\div$ 12 *in.* $= 0.2618$.

U. S. G. WAY.

Clearfield, Penn.

Power-Plant Curves

The curves plotted on the accompanying chart were worked up from a daily report sheet similar to the one shown on page 779 of the Nov. 26, 1912, number of POWER. This chart was drawn up to cover a period of one week, and the items noted are: Outside temperature, temperature of the water in the hot-water heating system, temperature of the feed water, amperes carried by the generator and coal used on each watch. All of the exhaust was used in the building heater and feed-water heater. Live steam was used for heating outside buildings, which at that time was not measured. The variations of the different items and their relations to each other can be grasped more readily than from a set of figures.



DECEMBER 1912

CURVES FROM POWER-PLANT LOG

On the first day, which was Sunday, it may be noticed that the load on the generators was light. The night load from 8 p.m. to 7 a.m. is about 125 amp. and is nearly the same every night. The day load from 7 a.m. to 8 p.m. is heavier and not always the same. On Dec. 18, which was a very dark day, many more lights were used in the offices and the load reached its highest point, which was about 800 amp. The extra exhaust steam caused the temperature of the feed water, and the water in the heating system to rise. The coal consumption was the same as on Dec. 19, when the load was much lighter. This was caused by a lower outside temperature which required more live steam to be used for heating.

The steam pressure is not plotted as it was steady at 100 lb., and would appear as a straight line, and likewise the exhaust pressure which was steady at 1½ in. vacuum, and the voltage at 225 volts. This chart can be drawn up to fit almost any set of conditions. It may cover a space of 24 hr., one week or one month, as desired, and the readings, which, in this case, were taken every two hours, may be taken as often as found convenient.

To plot the curves the sheet is first laid off in squares, as shown, or paper may be purchased that is ruled in this manner. Next the figures at the left and bottom of the chart are put down and the values from the daily report sheet plotted in the proper place on the chart. For instance, the temperature of the feed water at 9 a.m., Dec. 16, was 162 deg. Locate a point between the lines corresponding to 160 and 165 deg., and between the vertical lines that represent 8 and 10 a.m. The next reading showed a temperature of 168 deg. at 11 a.m. Locate a point in the proper place, and draw a line from one to the other. When the other points are located in the same way the rest of the curve may be drawn. Different styles

of line should be used for the different curves so that they may be easily traced and compared with each other. If it is desired to make one of these charts for every day or week it would be well to have them printed with all lines and figures in place. Then it will be necessary only to plot and draw in the curves.

If these charts are studied closely, they are sure to result in better economy and the engineer will have an intimate knowledge of what the plant is doing.

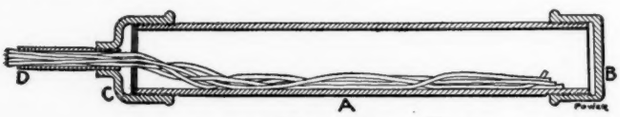
J. C. HAWKINS.

Hyattsville, Md.

Torch for Boiler-Inspection Work

Some time ago there appeared in POWER a description of a holder for a lamp to be used inside boilers. This ingenious arrangement brought to my mind a torch (by no means a new one) in use for the same purpose, which, possibly, does not require the care necessary with the lamp, as this torch burns equally well in any position.

One advantage of this torch, aside from the great convenience in inspecting boilers and in working in any dark restricted space, is the ease with which it may be made. Its great simplicity puts it within the reach of any handy man who has access to a hacksaw, a set of pipe dies, a vise and a few pipe fittings.



SECTION OF HOME-MADE TORCH

The illustration shows probably the most convenient size. A piece of 1¼-in. brass pipe *A* has a cap *B* on one end and a 1¼x⅜-in. reducing coupling *C* on the other. Into the coupling is screwed a ⅜-in. nipple *D*, about 2 in. long. A few strings of lamp wicking long enough to reach the bottom, complete the torch. Unscrew the coupling from the pipe, fill with kerosene oil, and it is ready for use.

J. F. MOWAT.

Joliet, Ill.

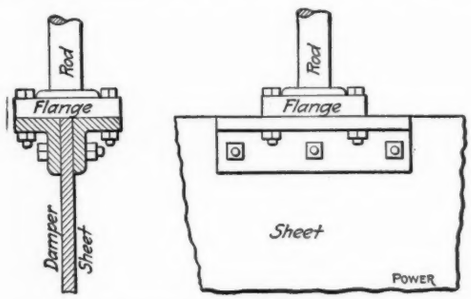
Troubles of Down-Draft Systems

The most common and, at the same time, the most annoying difficulties that arise in the operation of down-draft furnaces and systems are: Broken damper stems, both in the main flue and in the individual boiler settings, dampers held shut by collection of soot about the base, dampers rusted in their lower bearings, and last, but not least, leaks in the settings.

If the management will not bear the expense of forged stems, get a piece of rod or pipe, of a size and length necessary to suit, thread one end of it for a pipe flange, and bolt it to the top of the damper with two pieces of angle iron, as shown in the sketch. The rod or pipe should be securely headed down or peened into the flange so as to prevent its being screwed out. This repair on a broken stem may be quickly and cheaply made, yet it is strong and durable.

Many boiler men are familiar with the practice of laying a piece of perforated pipe along the base of the damper and blowing live steam through it to remove soot from around the damper base. The practice is to be condemned.

If the flue is not well drained, the water, which is almost certain to collect in it, will cause considerable annoyance by rusting the lower bearings of the damper stems, causing them to stick or jam in place, often resulting in twisting off the top stem without moving the damper. Of course, this trouble can be prevented by providing proper drainage for the flue, but in order to prevent a repetition of this trouble, bore out the lower bearing and place a brass bushing in it, allowing the stem to rest in the bushing. As the rust from the stem will have no effect on the brass, no further difficulty will be experienced with dampers rusting in one position. If



CONSTRUCTION OF DAMPER PARTS

the temperature of the flue gases is not too high, babbitt may be used instead of brass.

Leaks in the flue or settings are a source of constant trouble, annoyance and loss to the plant. Uneven settlement of the boiler settings is responsible for most of these leaks, and here again, the old adage of "an ounce of prevention is worth a pound of cure" comes to mind.

With induced draft, leaks in the settings will cut down the CO_2 percentage at a startling rate. This, of course, means a big loss of fuel. Again, slow fan speeds, coupled with leaks in the flue, result in dense clouds of smoke and gas, which, although not particularly detrimental, are very disagreeable and annoying, and, in some cases, may even be the cause of serious accidents.

There are other troubles and annoyances in the operation with the down-draft system, but the above are the most common.

W. C. COOPER.

Springfield, Ill.

Welding Boilers

Boilers have been repaired by the use of both the acetylene-welding process and by the electric weld. It has been my experience that insurance companies frown on the use of the former process. Whether or not they approve of the electric-arc process I do not know.

An article on this subject should prove very interesting reading. If either or both methods are not satisfactory it should be widely known, while in justice to the makers of this type of apparatus the reasons should be given.

The only objection I have ever heard given against the use of autogeneous welding is the possibility of defective workmanship. If this is the only reason, it would seem as though this might be overcome by having the work done by competent operators, approved by the insurance officials. If these processes are not objectionable, it is evident that the upkeep cost of boilers may be reduced.

JOHN BAILEY.

Milwaukee, Wis.

Home-Made Reducing Valve

Fig. 1 is a reducing valve that answers its purpose very well on a heating system that does not require the use of an expensive reducing valve.

Any globe valve of the proper size and having the seat and disk in fairly good condition may be used. To convert a globe valve to a reducing valve, remove the wheel and file the threads from the stem until the latter moves easily through the bonnet. The lever and its support may be secured from a discarded pump regulator.

To determine the weight to be used to secure the desired reduced pressure, the reduced pressure is subtracted from the boiler pressure, and the problem is then that of a lever safety valve with the difference between the boiler pressure and the reduced pressure as the blowing-off pressure.

Fig. 2 shows a device for grinding the seats of blowoff

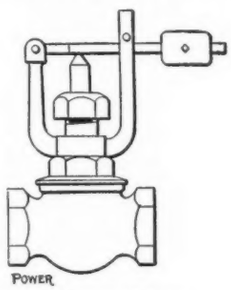


FIG. 1. HOME-MADE REDUCING VALVE

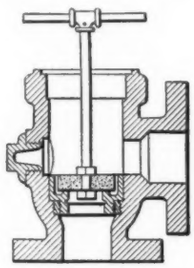


FIG. 2. VALVE RE-SEATING DEVICE

valves of the type having a flat seat and a disk containing a babbitt ring.

The grinder is a small alundum wheel of the same diameter as the valve disk. The handle is made of ¼-in. pipe; the grinding wheel being held between two locknuts on the end of the pipe.

A tee on the end of the pipe and two short pieces of pipe screwed into it furnishes grips for the handle. The stone is then turned on the seat with a downward pressure. Care should be taken when working on a brass seat as a very little grinding will make the seat as good as new.

GEORGE COLLISTER.

Salina, Kan.

Hole Worn through Piston

For rather unusual experiences, one which I recently had may be of general interest.

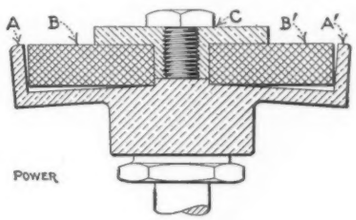
The engine in the plant to which I was sent acted as though it was working against a very high back pressure. Examination of the piston showed a hole worn through both sides of it from a bolt which had been left in it since it had been repaired.

W. M. LAY.

Irondale, Ala.

Repair to Valve-Disk Holder

It occurred to me that probably the monkey-wrench had played an important part in causing the valves in question to leak. On taking the valve apart we found the cause of the trouble. At A and A' is shown how the disk holder had been sprung, to all appearances, by excessive pressure brought to bear on the disk at B and B', undoubtedly caused by an overdose of monkey-wrench treatment applied to the valve wheel. I removed the retaining nut C, took out the disk and screwed the nut down on the stem to within $\frac{1}{32}$ in. of the bottom of the holder.



BENT GLOBE VALVE-DISK HOLDER

I then heated some babbitt metal, filled the holder to the top of the retainer. After it cooled I put it in a lathe chuck and faced off the bearing surface and this valve now holds tight.

CHARLES W. DUNLAP.

Depew, N. Y.

Trouble with Leaky Boiler Tubes

In our plant is a 72-in. horizontal tubular boiler containing 72 four-inch tubes, and I am bothered with the two outside rows of tubes leaking at the back ends. I have replaced these tubes twice in the last two years, and they are leaking again; the rest of the tubes have never given me any trouble and they seem as good as new.

Will some reader of POWER kindly tell me why these tubes give out while the rest remain tight?

E. H. HART.

Baskett, Ky.

Flue-Gas Readings for Criticism

The accompanying table is a record of one day's sampling of our flue gases. I would like to have readers criticize this record. It will be noticed that a minus sign is put before some of the CO readings. This sign indicates that the CO reads less than the O.

Time	B	CO_2	O	CO	Draft
10.05	4	18.8	2.	1.2	0.15
0.25	3	14.6	5.8	0	0.4
0.35	1	16.0	4.	0.3	0.2
0.45	4	15.8	4.2	0	0.46
11.00	3	15.6	4.8	—0.2	0.4
0.16	1	17.0	3.8	0	0.53
0.30	4	17.2	2.8	—0.2	0.3
0.32	3	13.0	7.8	0.	0.18
1.10	4	16.4	2.6	—0.2	0.2
0.28	3	14.8	4.6	0	0.25
0.45	1	14.6	5.2	0	0.32
2.10	4	14.4	6.4	+	0.38
0.25	3	14.4	5.4	0	0.26
3.00	4	14.8	4.2	0	0.24

I would like to have it explained why this occurs for some readings and not for others. The samples were taken from horizontal return-tubular boilers operating at 140 lb. pressure.

F. A. LOWE.

Boston, Mass.

[Readers submitting flue-gas analysis readings should state the kind of fuel used, the draft in inches, the method of firing and the kind of furnace and boiler used. This information will enable readers to comment on the readings and arrive at conclusions that are not mere guesses. —EDITOR.]

QUESTIONS BEFORE THE HOUSE

The Deadly Monoxide

By his article, in the Mar. 18 issue, under the above caption, Mr. Calloway has probably performed a good service in calling attention to the fact that a high CO percentage is not desirable in a boiler furnace. However, some of his statements are hardly correct.

He states that when the "expert" first noticed the CO percentage it was 14 per cent., and that it reached 15 per cent.; then being within 2 per cent. of its dangerous point. If he intends to convey the idea that carbon monoxide with a percentage of 17 under atmospheric pressure and of a temperature, such as exists in the combustion chamber of a boiler, will unite with the oxygen present and cause an explosion, he is wrong. As a practical proof, recall that in a gas producer the CO often reaches 23 to 25 per cent. with a temperature much greater than in the combustion chamber of a boiler and at a higher pressure (this is in the pressure type of producers). Under such conditions the CO will not become explosive until it unites with air, or rather oxygen, at a high pressure or at a temperature 500 deg. higher than the temperature in the combustion chamber.

As another example one might mention a number of types of stokers using forced drafts with sealed ashpits. With these stokers when the fan stops, due to high steam pressure, the amount of air entering the furnace is at a minimum and but little CO_2 is created. Up to the present time I have heard of no installation being wrecked, due to the CO uniting with the air that might enter through the walls.

However, 15 per cent. CO is entirely out of question in a boiler furnace, and I rather suspect his "expert" should have renewed his chemicals in the CO recorder or was an amateur in the handling of it.

L. H. Morrison.

Kansas City, Mo.

If Mr. Morrison is correct that there is no possibility of an explosion when the Orsat apparatus shows a CO reading of 17 per cent., then R. H. Thurston made a surprising mistake when he wrote his book, "Steam Boiler Explosions in Theory and Practice." Quoting from page 126 of this book: "Explosions of gas sometimes precipitate steam-boiler explosions Should the gases leaving the fuel and the furnace not be completely burned, but become so mingled in the flues as to produce an explosive mixture, combustion finally occurring, the shock may be sufficient to cause rupture of the boiler, and as has actually sometimes happened, its explosion."

Recently E. J. Rimmer wrote a book entitled: "Boiler Explosions, Collapses and Mishaps," based on data gathered by the British Board of Trade. He illustrates various points by referring to actual cases and on page 86 I find this reference to what happened in Case No. 1687.

"The gases from the flues passing from the boiler through the chamber came into contact with an overheated economizer, which ignited the gases and wrecked it."

Furthermore, Mr. Rimmer states that the temperature of this overheated economizer was high enough to cause combustion of the gases. As an economizer contains feed water, even in an "overheated" condition, its temperature could not have exceeded the normal temperature of the flue gases very much, so it is reasonable to suppose that at some point between 400 and 800 deg. the gases exploded.

There is no doubt that CO often reaches 25 per cent. in a producer without wrecking the plant. In the first paragraph of my article, it is stated that "it (CO) is, *when mixed in proper proportions with air* highly dangerous, because of its explosive quality." Well behaved producers get no air above the coal, where the CO is. Unfortunately, boilers do. As to the "much greater" temperature of the producer fire as opposed to a boiler's it might be pertinent to point out that coal burned to CO_2 produces, roughly, 14,000 B.t.u. per lb., whereas in burning to CO, only 4400 B.t.u. can be squeezed out of the same amount of coal. Also 2750 deg. is not unusual in a boiler furnace.

The other "proof" that Mr. Morrison relies on is the case of stoker-fired boilers with sealed ashpits and forced draft. He evidently thinks that practically no air enters the ashpit when the fan stops. Under these conditions the only avenue of entrance for the air is through a duct usually of several square feet cross-section in which the only obstructions are the blades of a fan, set edgewise. In fact, the free area is just the same as when the fan is running. And there is the fire in the furnace to induce a draft.

H. R. Callaway.

New York City.

Isolated Plant vs. Central Station

Allow me to answer some of my critics who quote other instances as a proof that the particular case to which I referred, in my former article, appearing in the Jan. 7 issue, was wrongly analyzed.

I am not "evidently promoting central-station interests," and no one in my particular territory has installed one-half as many isolated plants as I have in the face of the most strenuous, but generally fair-minded, opposition on the part of the public-service corporation.

My critics object to $20,000 per year as the cost of 185 kw. of generating capacity. I made no such statement. The figure given included generators and engines, switchboard, wiring, foundations, some 300 meters, piping, pipe covering, engineering and incidental expense; and the sum total was taken from actual competitive bids for the various classes of apparatus.

Just why 5 per cent. for depreciation on what is spent for labor is improper, I cannot understand. Certainly nothing depreciates so rapidly as the labor involved in erecting a plant, as it has no second-hand value; and when the plant is worn out, no part of the labor value can be recovered.

Mr. Eastman, in the Apr. 15 issue, objects to my figure of 4.8c. per kw.-hr. The present prices for that same building are $2400 per year for a fixed charge and less than 1c. per kw.-hr. for running charges, which includes the free renewal of lamps, if anyone wants to use the carbon-filament lamp; and most of the tenants do.

I repeat that the exhaust steam available from the isolated plant will be of little value. There are very few days in the year when the exhaust steam from the elevator pumps is not, in part, escaping to the atmosphere. In my own offices (which are in this building), it is a rare occurrence to have the steam turned on at all. On very cold days considerable steam is required throughout the day; but by 4 o'clock in the afternoon the building is thoroughly warmed, and it is probable that the temperature would not fall 5 deg. between 4 and 6 o'clock if all of the steam were shut off. The exhaust steam of a 100-kw. load would be practically useless. The exhaust steam of a 25-kw. load, through the day, might be useful; but no central station would make a favorable rate to a customer running an isolated plant for the steady load and purchasing current during peak hours only.

At present, a very small amount of labor is required, and that not high priced. The additional labor requirements to operate a plant, respond to the demands of the tenants, test and repair meters, and, in general, perform the functions of a public-utility corporation on a small scale, would add a very appreciable amount to the present costs.

Mr. Hickman's estimate of the cost of fuel, in the same issue, would hardly apply in this section. Instead of $2.50 per ton for coal, it costs, in this vicinity, nearly $4.50 per ton in front of the boilers.

It should be borne in mind that I was quoting a particular case to illustrate that there were probably many instances where conditions were most unfavorable for isolated-plant operation; and that each individual case must be approached in a most impartial frame of mind. Since writing my first article the public-service corporation has displaced an isolated plant which has been in operation for ten years and which was in almost perfect condition. It had a total capacity of 350 kw., operated 18 hr. per day, and had an unusually high load factor. A complete set of books had been kept in connection with this plant since the day it started, and the actual costs of operation were positively known. Nevertheless, the public-service corporation made a rate which left no room for choice, and that after allowing an excessive amount of fuel for heating purposes alone.

The plant has been running since November, 1912, on central-station service; and at the present writing the contract proves to be a most satisfactory one. Why? Because the central station makes a favorable rate; and that is the whole answer. It is not necessary to compare that rate with other rates, or to question whether it is just.

We very often lose sight of the fact that small power plants do not operate within the estimated costs. There is seldom brought to bear any considerable amount of executive ability, such as is exercised in the conduct of the main business; and this is no reflection on the actual operators of power plants. I admit that the central-station rates in Boston or New York make the isolated plant more than a possibility; but I was not, nor am I, writing about rates in Boston or New York. I am simply trying to state that what obtains in one place, or even one instance, is seldom of little value in another instance, except as it adds to the general fund of information and broadens a man's view. If some of the doubting Thomases are really interested, I shall be glad to give them figures which will prove that the isolated plant has a hard struggle for existence when the central-station rates get down to 1½ and 2c. per kilowatt-hour.

WARREN B. LEWIS.

Providence, R. I.

Available CO_2 Percentages

"Available CO_2 Percentage" is the subject of an article appearing in the Apr. 15 issue. The writer of the article gives a method for determining the available or theoretical maximum percentage of CO_2 for any given coal when the fixed carbon content is known. This information, if well founded, would prove very comforting to some engineers, particularly those in Missouri, where we burn coal containing as low as 33 per cent. of fixed carbon. To go a little further into the subject without becoming too technical is the object of the present discussion.

Theoretically perfect combustion of a coal may be expressed as combustion in which all of the combustible constituents of the fuel have been completely burned and further, that the products of combustion contain no excess air as indicated by the presence of free oxygen. Therefore, an Orsat analysis of the products of combustion from coal burned under theoretically perfect conditions would show only carbon dioxide (CO_2) and nitrogen (N). In other words, there would be no oxygen (O) or no carbon monoxide (CO) present. If the fuel were pure carbon, the analysis would show approximately 21 per cent. CO_2 and 79 per cent. nitrogen.

Carbon appears in coal in the form of free or "fixed carbon" and in combination with hydrogen, commonly known as "volatile matter." Under favorable conditions the carbon in the volatile matter burns to CO_2 and the hydrogen to water (H_2O) while under unfavorable conditions of combustion the volatile matter may appear in the products of combustion as unburned gases, tar and particles of free carbon or smoke.

In flue-gas analyses made with the ordinary three-pipette Orsat apparatus, the unburned hydrocarbon gases are not detected, or, in other words, they appear erroneously as nitrogen. If these unburned hydrocarbon gases are present in large quantities, as, for instance, when a coal containing a high percentage of volatile matter is burned in a poorly designed furnace and with an insufficient air supply, they produce a condition known to every Orsat operator as "low totals." Another cause for low totals is the hydrogen in the coal. Hydrogen requires for combustion eight times its weight in oxygen or thirty-five times its weight in air and the product of its combustion is water (H_2O), which, of course, does not appear in the Orsat analysis. Those who have analyzed gases from boilers in which natural gas is used as fuel are, no doubt, familiar with the very low totals obtained, due to the high percentage of hydrogen in this fuel.

When Mr. Pohlman in his calculation states that 14.7 per cent. of CO_2 is the theoretical maximum for coal containing 70 per cent. of fixed carbon, he neglects to take

into consideration the composition of the remaining 85.3 per cent. of the flue gases. There could in such a case be no free oxygen or carbon monoxide present; otherwise combustion would not be perfect and if this 85.3 per cent. was truly nitrogen, what has become of the oxygen which, in the form of air, might account for the presence of this unduly large amount of nitrogen?

A simple calculation will show the impossibility of this combination:

$$85.3 \times \tfrac{21}{79} = 22.7 \textit{ per cent. of oxygen}$$

In other words, 22.7 per cent. of oxygen must have originally accompanied the 85.3 per cent. of nitrogen in the form of air, and, since one volume of O combines with carbon to form one volume of CO_2,

$$22.7 - 14.7 = 8 \textit{ per cent. of } O$$

which must have disappeared from Mr. Pohlman's calculation. In order that this disappearance might be due to the presence of hydrogen there would be required, by a somewhat complicated calculation, approximately 16 per cent. of hydrogen in the coal. This is, of course, an absurdity, since the available hydrogen content of a coal containing 70 per cent. of fixed carbon is only about 4.5 per cent.

The writer is of the opinion that the available or theoretical percentages of CO_2 are not the criterion in an effort to approach perfect combustion. A more suitable method of procedure is to practically disregard the CO_2 and depend entirely on the O and CO. Perfect combustion is approached as these two quantities approach zero, but since the CO has a tendency to increase as the O decreases, care must always be taken to keep the former within proper bounds; otherwise the loss on one side will more than offset the gain on the other.

CO_2 recorders are of value only when the nearest possible approach to perfect combustion has been determined by means of complete flue-gas analyses and careful study.

E. J. Billings.

St. Louis, Mo.

A. Pohlman's letter on available carbon-dioxide percentages contained some statements which appear to be based on a slight misunderstanding of the principles of combustion. It is quite correct that pure carbon burned in air under laboratory conditions would produce a flue gas with a maximum of 21 per cent. of CO_2. It is also true that most coals would not produce that amount of CO_2 when burned under the most favorable conditions. The maximum amount of CO_2 obtainable cannot be obtained in the simple manner stated, i.e., by multiplying the percentage of fixed carbon by 0.21.

The constituents of coal that are determined by what is known as a "proximate analysis" are: Moisture, volatile matter, fixed carbon and ash. Assuming ideal combustion for maximum CO_2 production, we would have to supply enough air to furnish oxygen not only for the combustion of the fixed carbon, but of the volatile matter also. This volatile matter varies with different coals, and is usually composed of some CO_2, some free hydrogen and nitrogen, ammonia, sulphur and a large proportion of complex hydrocarbons, ranging all the way from benzene and methane to anthracene and the heavy tars.

It is evident, therefore, that there is much carbon in this volatile matter, and that its combustion will produce CO_2, which will swell the total produced from the fixed carbon. Assuming 3 per cent. moisture, 30 per cent. volatile, 60 per cent. fixed carbon and 7 per cent. ash, the CO_2 from the volatile will be about one-fifth of the total CO_2. This is based on the assumption that the volatile matter is one-half carbon by weight and this is a conservative estimate.

The remainder of the volatile matter, the hydrogen, sulphur and ammonia will consume oxygen without producing a corresponding amount of CO_2, and, therefore, would dilute the flue gases, thereby reducing the percentage of CO_2. This dilution would not be in direct proportion to the relative percentages of carbon and hydrogen. One unit of carbon requires two and two-thirds its weight of oxygen for combustion, while a unit of hydrogen requires eight times its weight of oxygen for combustion. The relation between volatile matter and carbon-dioxide percentages is, therefore, not nearly so simple as the formula Mr. Pohlman assumes.

The percentage of moisture and ash would tend further to complicate the calculation of the carbon dioxide obtainable from the fixed carbon in the coal. So far as the combustion is a purely chemical reaction, they are absolutely inert. In other words, if we took a pound of pure, dry carbon and burned it completely with the right amount of air, we would get the same heat value and the same CO_2 value as we would if the pound of carbon was well ground and mixed with inert matter like sand, clay, limestone, etc., which would closely resemble the ash in ordinary coal.

Mr. Pohlman well states that the determination of CO is important. It would seem that the percentage of oxygen in the flue gas is equally important. One constituent shows if there is a deficiency of air, and the other if there is an excess. It is well known that there must be considerable excess air with most coals and boiler designs, but no definite rules can be laid down. Each coal and each boiler design and setting modify the conditions to such an extent that only an actual test will furnish accurate information. Only enough excess air should be added to keep the CO less than three or four-tenths of 1 per cent.

It should be stated in this connection that it has been found in most cases that the above conditions are best realized when the CO_2 content is the highest. This is so because any decrease in the amount of air below the most efficient figure would reduce the CO_2 by the formation of CO, from lack of oxygen. On the other hand, any increase in air would dilute the gases so that the CO_2 would be lowered. A complete analysis should be made at convenient intervals as a check on the CO_2 recorder, and to insure the proper combustion of the fuel.

C. H. Southern.

Birmingham, Ala.

Names for Steam Stuff

Supplementing my letter in the Apr. 8 issue, suggesting "hydrol" as a name for wet steam stuff, how is "hyperdrol" for superheated steam or "pyr-hydrol"? It is made up of hyper + hydrol, or it can be hy + (pyr = fire) + drol = hyperdrol or pyrhydrol.

Really the last, "pyrhydrol," is the better.

C. S. Palmer.

Newtonville, Mass.

INQUIRIES OF GENERAL INTEREST

Ball-Gage Cock Packing—What is the best packing for ball-gage cocks?

H. F.

Most ball-gage cocks are made to receive sheet packing. Plumbago sheet packings are preferred by many.

Pumping Water from Air-Tight Elevated Tank—Can all of the water be pumped from an air-tight tank 15 ft. above the pump?

E. J. K.

All of the liquid water could be pumped out, but a vapor of water would fill the space after the water was removed from the tank, all of which could not be pumped out.

Tungsten Lamp Discoloration—Why do some tungsten lamps, after burning for some time, appear as though the inner surface of the globe is plated with copper?

T. H. W.

Lamp manufacturers seem to disagree upon the composition of this deposit. Some claim that it is an oxide of tungsten due to the presence of the trace of air it is impossible to exhaust from the bulb. Others attribute it to impurities in the tungsten which have vaporized out under the high temperature and condensed on the glass.

Erratic Safety Valve—A 4-in. lever safety valve ground tight in its seat, set to blow at 100 lb., starts to blow at 80 lb. and will not stop until the pressure falls to 60 lb., unless the valve is pressed down to its seat. When additional weight is put on the valve it will not blow at 100 lb. What is the matter with the valve?

H. F.

The valve may be ground tight, but has not a good straight beveled seat all around. It probably has been ground rounding, for the action described is due to the valve getting cocked on its seat.

Corliss Dashpot—What is the function of the dashpot on a Corliss engine and how does it work?

J. P.

Its main purpose is to quicken the action of the steam valves in cutting off. A dashpot works similarly to a piston working in an air cylinder. On the upstroke it holds the valve-releasing gear to its position, and, a partial vacuum being formed in the dashpot during the upstroke, the piston is forced down in the cylinder by atmospheric pressure assisting the cutoff to quicker action. The dashpot itself is cushioned on its down stroke by a small amount of air admitted under it during its upstroke by a small cock provided for that purpose.

Required Size of Wire—Some machinery, situated about 200 ft. from the dynamo (334-kw., shunt-wound, direct-current, 30-amp., 125-volt) is to be driven by a 5-hp. motor. Is it allowable to connect the motor on the same circuit with four 16-cp. lamps? What size wire should be used?

B. F. H.

The motor may be connected on the same circuit with the lights. The size wire to be used will depend largely upon the voltage drop allowed between the generator and motor. Allowing a drop of three volts a No. 4 wire might be used. This is capable of carrying 65 amp., if rubber covered, and 92 amp., if covered with weatherproof braid. A No. 6 wire which, rubber covered, may carry 46 amp. and, weatherproofed, 65 amp., will cause a drop of 5 volts between the two machines. With smaller wires the drop would be greater. The No. 6 wire would be large enough. It would carry a 50 per cent. overload without serious heating and the generator could easily be excited to give 5 volts higher pressure than required by the motor.

Corliss Valve Advantages—What advantages have Corliss valves over slide valves? What advantages have they in condensing engines?

J. P.

Corliss-valve advantages are mainly that they offer less frictional resistance to motion than slide valves; that they are controllable directly from the governor; that they can be operated and regulated by the governor so as to remain wide open until the proper point of cutoff is reached, and will close quickly with little or no wire-drawing effect; that they allow shorter steam passages and less percentage of clearance space. Their advantage in condensing engines is that they can be made to give a sharp cutoff without wire-drawing the steam, and, consequently, a full effect of expansion in the high-pressure cylinders and give a full opening of the valve until the point of cutoff in the low-pressure cylinders. Another advantage is that with Corliss valves the exhaust valves being placed on the bottom of the cylinders there is less danger of water accumulating in the cylinders, because the exhaust ports afford drainage by gravity.

Loss of Voltage—A shunt field dynamo (33 kw., 1125 r.p.m., 250 volts, 80 amp.) loses about 50 volts in four hours' running under load with the rheostat turned as far as it will go. When the load is off it will excite to 300 volts. It gets very warm but not injuriously hot when the load is on. The engine does not decrease in speed. What is the trouble?

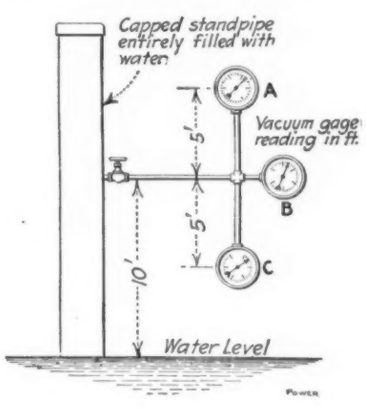
P. S.

From the symptoms the loss in voltage is due primarily to friction of the brushes, causing them to heat up and chatter and also deposit carbon on the commutator. This increases the resistance and tends to reduce the voltage. An application of oil to the commutator when warm would probably remedy the trouble. It should be put on sparingly with a piece of canvas or other material that will not deposit lint. Graphite brushes also might help. If the commutator is rough, it should be smoothed.

Pressure in Standpipe—Referring to the accompanying diagram, what will be the readings of the three gages as shown when the capped standpipe is entirely filled with water? What would be the readings if the gage pipes were first drained of all water before the valves were opened?

W. F.

The pressure at the water level is atmospheric (14.7 lb., or 33.947 ft., or, roughly, 34 ft.) At any point in the standpipe the absolute pressure will be less than that equivalent to a head of 34 ft. by the height of the point under consideration above the free water level. Where the gage pipe attaches, therefore, the absolute pressure will be equivalent to a head of



$$34 - 10 = 24 \text{ ft.}$$

This, then, will be the reading of gage B. Gage A being 5 ft. higher, its reading will be 5 ft. less, or 19 ft., and gage C being 5 ft. below B, its reading will be 29 ft.

If the gage pipes were first drained of water they would become filled with air at atmospheric pressure. Thereafter, if the valves were opened some of this air would escape into the standpipe until the pressures were again balanced. Water would displace all air in the horizontal pipe and the vertical pipe on gage C. The air in the pipe of gage A would remain pocketed. The pressure on gage B would be 24 ft., as before; on gage C 29 ft., as before, but on gage A it would be the same as on gage B, 24 ft., except for the subtraction of a head of air of 5 ft., which would be negligible.

ENGINEERS' STUDY COURSE

Analysis of Coal

Those who tackled the problems given in the concluding paragraphs of the last section may be anxious to know how they succeeded, so we will work out the answers now before getting down to the subject of the day.

Substituting in the formula preceding the questions, the weights of carbon and hydrogen per pound of coal given in the problem, we have

$$W = 11.52\,C + 34.56\left(H - \frac{O}{8}\right)$$

$$W = 11.52 \times 0.7875 + 34.56\left(0.05 - \frac{0.02}{8}\right)$$

$$W = (11.52 \times 0.7875) + (34.56 \times 0.0475)$$

$$W = 9.07 + 1.64 = 10.71\ lb.$$

air required per pound of coal. As the weight of the products of combustion always equals the weight of air required plus the weight of the combustibles themselves, we have

Wt. of air required + Wt. of carbon + Wt. of available hydrogen = Wt. of products of combustion

$$10.71 + 0.7875 + 0.0475 = 11.54\ lb.$$

In finding the weight of air required for the combustion of the fuel oil, exactly the same formula is used as in the case of coal, except that the available hydrogen, represented by the term $H - \frac{O}{8}$, is given and, as a result, our work is simplified,

$$W = 11.52\,C + 34.56\left(H - \frac{O}{8}\right)$$

$$W = (11.52 \times 0.8485) + (34.56 \times 0.1115)$$

$$W = 9.77 + 3.85 = 13.62\ lb.$$

of air required per pound of oil. And, in the same way as before, the weight of the products of combustion are

Wt. of air required + Wt. of carbon + Wt. of available hydrogen = Wt. of products of combustion

$$13.62 + 0.8485 + 0.1115 = 14.58\ lb.$$

According to the definition previously given, a B.t.u., or unit of heat measurement, is the amount of heat required to raise the temperature of 1 lb. of water 1 deg. F. In the third problem there are 7575 lb. of water per hour to be raised in temperature. Then,

$$197.5 - 73 = 124.5\ deg.$$

$$7575 \times 124.5 = 943{,}087\ B.t.u.$$

are being put into the water per hour.

Coal Analysis

When you analyze a fuel you find out what it is composed of. In previous lessons we saw that the combustible or burnable makeup of all fuels consists of a few elements: Carbon, hydrogen and sulphur. Besides these combustibles a fuel contains oxygen, nitrogen and ash.

Now as the heat value of a fuel depends upon the amount of carbon, hydrogen and to a slight extent sulphur which it contains, it may be important to know what the analysis or makeup of a given fuel is so as to be able to estimate what amount of heat ought reasonably to be expected from its combustion under the boiler.

Ultimate Analysis

There are two kinds of fuel analysis; they are called ultimate analysis and promixate analysis. The ultimate analysis tells the amount of carbon, hydrogen, oxygen, nitrogen, sulphur and ash which the dry fuel contains. In other words, ultimate analysis means complete analysis, giving the proportions of all the constituents.

To make an ultimate analysis requires expert skill, costly apparatus and a much more advanced knowledge of chemistry than we need for our study here. Ultimate analyses are seldom attempted by any but expert chemists in regular laboratories suitably fitted for the purpose. However, reports of ultimate analyses of the coal or oil of a certain district, seam or mine are often available, and, consequently, it is well to know what an ultimate analysis is and how to use it in estimating the heat value of a given fuel.

Proximate Analysis

The approximate, or as it is usually called, proximate analysis, gives the amounts or percentages of moisture, volatile matter, fixed carbon and ash contained in the fuel.

Coal is about the only fuel to which the proximate analysis is applied, although, of course, the proximate analysis of any solid fuel can be made. The proximate analysis of fuel oil is practically useless as in the average case there would be but one item, the oil being nearly all volatile matter.

The moisture is, of course, the amount of water which the coal has soaked up and this is liable to vary in a given coal from time to time, depending on the way the coal is stored, state of the weather, etc.

The volatile matter consists principally of the hydrocarbons described in the first lesson on this subject. When we say that a thing is volatile, we mean that it can be changed from the solid, the semi-solid or from the liquid state into a vapor fairly easily, and without having its nature changed; that is, without undergoing a chemical change. Quicksilver, or mercury, is a liquid-like metal which can be turned into a vapor, therefore, mercury is volatile.

In fuels, the hydrocarbons can be changed into vapors at fairly low temperatures and driven off without being burned, hence, they are called volatile. These hydrocarbons exist in a great variety of form; that is, although they all consist of nothing but hydrogen and carbon, the proportion of each varies greatly, making substances of different characteristics. Thus, marsh gas, or methane, has the chemical formula CH_4; acetylene, C_2H_2; olefiant gas, C_2H_4; ethane, C_2H_6, etc. Each combination has its own physical qualities. Some, known as "light" hydro-

carbons, have the quality of vaporizing at fairly low temperatures while others, known as "heavy" hydrocarbons, do not vaporize until the temperature becomes very high. For instance, gasoline is a very light hydrocarbon, as it changes into a vapor at about 200 deg. F., while cylinder oils are composed of heavy hydrocarbons because they remain liquid at temperatures as high as 600 deg.

The fixed carbon is the pure or uncombined carbon which remains after the heating process has vaporized the hydrocarbons; it can be driven off only by actual burning and not by any process of vaporizing or distillation.

The ash is simply the unburnable solid matter which fuel contains, and consists principally of slate, dirt, etc.

The proximate analysis is not difficult to make and it is valuable in comparing one lot of coal with another, in estimating the heat value and in checking up furnace operation.

The proximate analysis consists simply of heating an accurately weighed sample at a low temperature, for a certain length of time to dry out the moisture. The sample is then weighed again; the loss in weight divided by the original weight is taken as the percentage of moisture. The second heating (at a higher temperature this time) and the third weighing give the volatile matter. And from the third heating (at high temperature) and

FIG. 1. DIAGRAM OF METHOD OF QUARTERING SAMPLE

fourth weighing, the fixed carbon and ash are determined. Details of the method will be given later.

TAKING THE SAMPLE

There are really two steps to be taken in securing a proximate analysis: First, selecting the sample; second, making the analysis itself. The reliability of the results depends upon the care taken with each step.

In selecting the sample, the object is to secure a small quantity of coal which represents the average character of a very large quantity. If the coal were of uniform character all the way through, or if the lot to be sampled could be thoroughly mixed or stirred, it would be an easy matter simply to pick up a few lumps or handfuls at any convenient point and use them as the sample to analyze. But as such is not the case it is necessary to select many small quantities from all parts of the lot, of such size that when all are put together the pile will be small enough to thoroughly turn and mix after which a suitable sample can be taken therefrom. No exact rules can be offered to suit all cases, and the method of samping must be adapted to the local conditions. If the quantity of coal to be sampled is large, care must be taken to avoid making the sample pile too large to work thoroughly, yet, at the same time, the pile must be composed of as many small samples as possible in order that it will closely represent the real character of the coal.

One commonly used method where coal is received in carload lots is to make a corer which can be driven down through the coal in several places in the car. This method gives samples of the coal from top to bottom at the various points, and when thoroughly mixed these samples may be taken as a fair average for the whole car. The corer may be made out of heavy 2- or 2½-in. iron pipe, 5 or 6 ft. long, sharpened at one end and with the other end capped or reinforced so that it can be driven with a sledge. Enough samples should be taken with the corer to make a large sample of 50 to 100 lb. Any lumps in this large sample should then be crushed so that there are no pieces larger than ½ in. diameter, after which the sample should be thoroughly mixed and "quartered down" until about 5 lb. remain.

This "quartering down" is done by spreading the sample out thin in the shape of a circle; dividing this circle into quarters, and throwing away the first and third quarters, as shown in Fig. 1. Thus, the quantity is reduced one-half. The two remaining quarters are then mixed thoroughly, spread out and again quartered. This process is continued until the remainder of the sample is of the desired size.

If the sample is not to be analyzed right away it should be put into a glass jar or a tin fitted with a tight cover and stored in a reasonably cool place until used.

Annual Dinner of Heating Engineers

May 12 was the date, and the place was the Engineers' Club. The annual dinner of the New York Chapter of the American Society of Heating and Ventilating Engineers was a great success. Just 148 enthusiastic rooters sat down to table and under the skillful guidance of the jovial toastmaster, Homer Addams, spent a most enjoyable evening.

After the cigars and coffee stage, C. R. Place was called upon to explain the mysteries of the Grand Central Station, which covers an area of 80 acres. Three-wire, direct-current service and forced hot-water heating are supplied through a series of tunnels from a central station. The water travels 7000 ft. to supply 500,000 sq.ft. of radiation and for the coming winter 100,000 sq.ft. of radiation in the Belmont Hotel will be added. All heating is done by direct radiation, and ventilation, with air washers and humidity control, is effected with tempered air. The two track levels below the surface are supplied with 1,000,000 cu.ft. of air per minute.

John F. Hale spoke of the old days in Chicago when the first chapter of the society was formed, and commented on the remarkable growth of the New York chapter. Their influence and that of the Boston chapter had been a salient factor in the success of the parent body. Before their organization it had been hard to get together. Much was left for the annual meeting and very little was accomplished.

"Industrial Education" was the topic of F. G. McCann, president of the chapter. He is greatly in favor of the vocational school, where the aptitude of the pupil is sought, and he is trained in the particular line to which

he is best suited. Besides learning a trade the student is instructed in citizenship and is developed into excellent material for a thoroughly good mechanic.

In these days specialization is so marked that there is no place for the apprentice. One gang may rough in the installation, another put in the risers, still another the fixtures, a fourth the brass work and so on. Each gang becomes expert in their own particular work and are kept at it. An apprentice might work for years and only become familiar with one phase of the subject.

In the past Great Britain has supplied many of the best steam fitters and plumbers. The loss of her best men was the cause of a raise in wages, so that she is now holding on to them and we must look elsewhere. The trade schools of some of the larger companies have not worked to their own advantage. The coöperative school in Cincinnati has given good results, but there most of the manufacturers are engaged in the one line of machine-tool building. In New York it would be difficult to get together all the firms of one line without considering the others, so that the same system would probably result in failure.

The broad training obtained in vocational schools is desirable and it is to them that we must look for the best material to carry on our trades.

A. S. Armagnac talked "shop," his subject being "Publicity." He referred to the unfortunate condition of the public and the engineer not getting together on a common basis. The public will not talk in engineering terms and the engineer sticks to the phraseology of his profession. A little coöperation is needed. Chicago has a heating and ventilating engineer and so has Cleveland. Every city in the country should have a board of heating and ventilating engineers. This is publicity of the right kind, and to obtain results the members of the chapter and the parent body must pull together and boost the cause.

The "kid in engineering," George G. Schmidt, spoke of the difficulties encountered by the young man. He appealed to the kids of yesterday to "loosen up" and give the novice the benefit of their experience. Books were at hand and plenty of them, but the older men of experience were needed to pick out the "coal." A course in heating and ventilation conducted at the headquarters of the chapter was suggested.

Dr. H. H. Franklin was the last speaker. His subject was "Purification," and was illustrated with numerous stories that were right to the point, and brought home to his listeners the proper use and benefits of ozone.

BOOKS RECEIVED

ENGINEERING THERMODYNAMICS. By Dr. Charles E. Lucke. McGraw-Hill Book Co., New York. Cloth; 1188 pages, 6x9½ in.; 328 illustrations; tables; indexed. Price $8.

AIR COMPRESSION AND TRANSMISSION. By H. J. Thorkleson. McGraw-Hill Book Co., New York. Cloth; 201 pages, 6x9½ in.; 143 illustrations; plate; tables; indexed. Price $2.

PRACTICAL MATHEMATICS. Part IV. By Claude I. Palmer. McGraw-Hill Book Co., New York. Cloth; 147 pages, 4½x7 in.; 68 illustrations; tables; indexed. Price 75 cents.

❖

A new heat indicator is a bright red paint which turns almost black before reaching the boiling point and resumes its normal color when it cools again.—"Compressed Air Magazine."

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

In a convention city recently an enterprising but tactless dry goods dealer displayed this sign:

OUR VISITING DELEGATES SHOULD AVAIL THEMSELVES OF OUR OFFER FOR THIS DAY ONLY: SHIRTS RETAILED AT WHOLESALE PRICES.

Across the store front was this one:

FORCED TO RETIRE. TROUSERS ONE-HALF OFF!

The latter is one good reason for retailing the shirts.

❖

You eat pie with your lunch? Then watch out for a feller the pure-fooders call Ben Zoate, of Sody, wherever that is. Of course, if your brand is the good old home-made product that mother used to mold, you're in right; if your pie is molded in a pie foundry or after a chemist's formula, the pure-fooders say you're in danger of being pizened, sure.

❖

Can you can power? You can power, Rollo, if you can call a battery a can. Everything is canned these days from suds to songs, from lobster to illumination. Frinstance, supposing you are eating up the road at 60 miles an hour on your way to work in your auto and suddenly your standardized batteries give out. You stop at a garage. To have them recharged and wait steen hours? Can that old stunt! Your batteries are whipped out, other standardized and charged batteries are whipped in, you throw in the clutch—and you're off ag'in, Finnigin. Canned power did it. Don't believe it? Well, by the time some of us have bought an electric car (meaning a motor car) this will have come to pass; perhaps sooner. The scheme sounds feasible—and fees-ible.

❖

A special tug has been built to assist in "nosing in" the "Imperator" when she comes to New York. The tug is 118 ft. long, 27.5-ft. beam, and has 1100-hp. in engines. Its speed is 14 knots.

❖

CONVENTION TIME

By Billy Spills

It's here at last for some of us! So let's dust the old suitcase, pack our extra shirt and socks, our typewritten speech, a flask of good "lining for our under-flannels," our return ticket and some stogies, and we'll be all dolled out for that convention "which this year promises to exceed all previous efforts."

The National Electric Light folks will be toted to Chicago in what they call "pink," "golden poppy" and "maroon" special trains. Well, they've got the kale to indulge in these flossy things if they want them. It sure sounds classy.

As for us, we're going to Springfield, Yonkers, Newark, Terre Haute, Toledo, Milwaukee and elsewhere in the good old way. We'll dig up a corner in the smoking-car alongside some feller that years ago we used to fire with in the Sunnyside power plant, and we'll swap smokes and our "cure" for rheumatiz; we'll blow about our kids; tell what we'd do with the plant if we owned it, and fix a warm place in Gehenna for the central-station folks—if we belong to the "isolateds"; we'll have our little gabfest about the turbine and the reciprocating engine; we'll be so dum glad to see each other that—

Say, bo! the good old way is the only way. You and I don't want any of the flossy things in ours, do we?

We're going to do our duty to old man Uplift and Mister Goodoftheorder when we get on the grounds, and in between we'll have the time of our lives for a few days. Then when we get back home we're going to make ourselves believe that the old job isn't such drudgery after all; that perhaps we went stale or sour for want of a rest-up or a glimpse of real scenery.

But, whisper! We're not going to bring home even one souvenir—if we can help it. You and I know there's always a few fellers in a big crowd that are too ding keen for the rough stuff, and sometimes they give the rest of us a bad name.

And whisper again; We won't intentionally offend any well-meaning party who forces a souvenir on us, but we're starting out bravely to do the right thing, and we hope to get away with it. So good luck be yours, boys—and Prosit!

NEW PUBLICATIONS

SAFETY VALVE RATING. By Alfred B. Carhart. Published by the Crosby Steam Gage & Valve Co., Boston, 1913. Cloth, 105 pages, 6x9 in.; illustrated; tables.

This interesting book with the above title is just off the press. The author, Alfred B. Carhart, does not believe in the present methods of rating safety valves. The rules now in common use for calculating the proper size of valve show valve area, and do not properly consider the lift. In his opinion it would be much simpler and more satisfactory to have the formula indicate the diameter, as was done by that suggested editorially in "Power" about two years ago by F. R. Low. In the first few pages of the book he cites his reasons, and compares the rules in most common use.

In equipping the steam boiler ordinarily used for power, safety valves are rarely smaller than 3 in. or larger than 4½ in. If for the four-valve sizes between these limits, it might be assumed or required that the lift be made the same, as is now quite fairly true in practice, then Mr. Low's formula might be used:

$$\text{Dia.} = \text{constant} \times \frac{W}{P}$$

in which W equals the total pounds of water evaporated per hour by the boiler (grate area × rate), and P equals the absolute pressure of the steam in pounds per square inch. By assuming a lift of 0.0875 in. for bevel-seated valves, or 0.06 in. for flat-seated valves, the formula reduces to the very convenient form of

$$\text{Dia.} = 0.1 \frac{W}{P}$$

If it is thought desirable to require the larger valves to lift higher than the smaller sizes, then it is still possible to formulate a rule in simple terms which will give the commercial diameter size directly and conveniently. When the lift is made a direct function of the valve diameter, increasing with the size of the valve, the general formula would be

$$D = \text{constant} \sqrt{\frac{W}{P}}$$

The objection should not be urged that this formula involves calculating the square root of the variable quantities, as a short table could be provided giving the maximum value of $\frac{W}{P}$ corresponding to each commercial valve size, and it would be only necessary to determine or memorize five or six values.

It would seem desirable not to make the lift of safety valves increase in proportion to the size of the valves. Such uniform increase in lift may appear to give a simple formula for calculation, but it does not work out well in practical application. To make the ratio of lift to diameter variable, would require factors of the second or third power in the calculations.

A new proposal is that valves used at lower boiler pressures may well be made to open more and to lift higher than valves at higher steam pressures. The strain upon the valve is not so great at low pressures, yet present rules assume that a certain size of valve will always lift the same amount, no matter what the working pressure is. This requires that for a boiler of given horsepower at 100 lb. working pressure, the proper valve must be almost double the size required for a working pressure of 200 lb., or half the size required at 50 lb. For at the lower pressures less steam would be discharged through a given area of opening, if the valve size and lift be fixed, since the quantities of steam discharged are in proportion to the absolute pressure, according to Napier's rule.

As the reaction and pounding of the valve or the wear upon the seat is much less at low pressure, the total spring load upon the disk being less, the valves might be allowed to lift higher for the lower steam pressures without increasing the practical difficulties. No rule thus far proposed takes this into account, yet it would be practicable to do this. All manufacturers could easily provide springs for each pressure, which would allow the valve to lift more for low pressures and restrict the lift for higher pressures.

Rather than make the valve lift vary with the absolute pressure it would be better to assume a certain fixed lift as the base of minimum, and allow an additional amount which would vary inversely as the pressure, the total of these two factors being the permissible total lift of the valve. It would only be necessary to fix upon the proper or desirable value of the lift for each valve size, and substitute these values in the calculation based upon the general equation,

$$D = \text{constant} \sqrt{\frac{W}{P}}$$

This is the rule preferred by the author.

An empirical rule is also suggested in which the desirable amount of valve lift for each case might be determined by taking into account past and present experience, with due allowance for considerations of absolute safety, the longest life and greatest certainty of satisfactory operation of the valves, comparing the various selected values with each other so as to make them suitably proportioned and bearing a fair relation to the present measured lift of safety valves, in so far as the practice of the several manufactures conforms to the best engineering judgment and requirements. Having set down a suitable lift arbitrarily fixed upon for each valve size and pressure, the corresponding steam discharges could be calculated according to Napier's formula, and tabulated for easy reference. The valve lifts determined would necessarily be considered as minimum requirements which all valves must at least show.

Each formula is fully discussed in the book, and the practicability of its use viewed from all angles. The subject is an important one, and those interested in this line would do well to read the book carefully. Although copies are to be sent out by the Crosby Steam Gage & Valve Co., the treatment was not written from a manufacturer's standpoint.

Kansas N. A. S. E. Convention

The first annual convention of the Kansas State Association, N. A. S. E., was held in Topeka, at the Commercial Club, on May 7 to 9. About 200 engineers attended.

At the opening session Mayor Cofran, of Topeka, made the address of welcome. "As we have been a builder and operator of engines for many years," said the mayor, "we have a sort of fellow feeling in common with you. As an engineer we installed the first engine in the city of Topeka for the operation of a newspaper plant that was known at the time as the 'Topeka Record.' We also sold the first engine used by the Atchison, Topeka & Santa Fé Ry. for its power plant."

L. E. Weaver, president of the association, responded in a few well chosen words. J. Will Kelley, secretary of the Commercial Club, made an address of welcome in behalf of the business men of the city. Wiliam Pulliam, assistant state secretary, responded and concluded by introducing National President McGrath, who spoke on the growth and standing of the association. The Rev. Mr. Corwine, of the Third Christian Church, pronounced the invocation.

Among the speakers were Fred Raven, secretary of the national organization, and John Dawson, attorney-general.

On Thursday morning a business session was held in the main room of the Commercial Club, and in the afternoon George H. Hodges and Prof. E. B. McCormick, of the State Agricultural College, made addresses.

Among the entertaining features was a picture show by the Topeka Commercial Club. The visiting ladies were taken to the Novelty Theater, on an automobile ride, and on a shopping tour by the local committee under Mrs. William Houser. On Friday evening the closing feature was a banquet at the Throop Hotel.

C. H. Van Dyke, of Atchison, was elected secretary. These other principal officers were reëlected for another year: President, L. E. Weaver, Kansas City; vice-president, E. S. Miller, Kansas City; treasurer, F. R. Hunter, Parsons. J. B. Dobbs, of Atchison, was elected state deputy. Trustees are: E. H. Burg, of Fort Scott, for one year; N. E. Vandyne, of Parsons, for two years, and William Pulliam, of Topeka, for three years. Fred Palmer, of Topeka, was chosen conductor, and H. A. Norton, of Port Scott, as doorkeeper.

Atchison was chosen as the next meeting place in 1914.

An interesing exhibit was made by the supply men in the Auditorium.

OBITUARY

SAMUEL L. MOYER

On May 3, after a brief illness, Samuel L. Moyer, first vice-president and general manager of the Lunkenheimer Co., Cincinnati, Ohio, died at his home in that city, in his fortieth year. Mr. Moyer was connected with the company for nearly

23 years and had worked his way up to the position he occupied at the time of his death by untiring energy and marked ability. He was prominently mentioned as a mayoralty candidate in his home city and had served two terms in its city council. Mr. Moyer was very generous, but giving of his means so quietly that few knew of his generosity. He was a member of the Cincinnati Business Men's Club, National Metal Trades Association, Queen City Club, Cuvier Press Club, and several others. He leaves a widow.

FRANCIS M. RITES

Francis M. Rites, the inventor of the well known inertia governor bearing his name, died suddenly at his home near Slaterville Springs, N. Y., on May 8.

Mr. Rites was born in Illinois in 1858. He was graduated from Cornell University with the degree of mechanical engineer in 1881, and was traveling engineer in 1883 for the Westinghouse Machine Co., and afterward a draftsman in the employ of Westinghouse, Church, Kerr & Co. Later he was steam expert for the Westinghouse Machine Co.

Mr. Rites' most conspicuous work was the Rites governor in its many forms and applications. It is so well known that its description and development need not be dwelt upon. In "Power" of July, 1902, Mr. Rites described the Rites governor and its adjustment and regulation. He was a member of the American Society of Mechanical Engineers and other technical societies. He was 55 years old.

HORATIO A. FOSTER

Horatio A. Foster, well known as an author, who had charge of the appraisal work of J. G. White & Co., died suddenly in New York City, on Apr. 27. Mr. Foster was born at Bustleton, Penn., on Jan. 12, 1858.

His electrical engineering training began in 1884, with the Daft Electrical Co. The following spring he was sent to Baltimore to electrify a short branch branch for the Baltimore Union Passenger Ry. Co., the first commercial electric railway in the United States. Later he went to the Thomson-Houston Electric Co., Lynn, Mass., and in the fall of 1888 he was superintendent of the East River Electric Light Co., New York City, remaining until July, 1891. He was then appointed an expert for the United States Census Office to compile data on the electrical industry of New York State, the only state which took an electrical census in 1890. Late in 1893, Mr. Foster became associated with Prof. Forbes, electrical engineer of the Niagara Falls Power Co. Early in 1895, Mr. Foster joined the staff of the Cataract Construction Co., Niagara Falls, as testing engineer for determining the cost of steam power, which work occupied about a year and a half.

After some years in consulting work, Mr. Foster was in 1901 appointed receiver of a brewery trust in Philadelphia which had failed. During this period he had also several important engineering undertakings. In 1906 he was placed in charge of L. B. Stillwell's work for the United Railways & Electric Co., Baltimore, in rehabilitating its generating and distribution system. In 1908 he was retained by Bion J. Arnold, Chicago, and assisted in appraising the property of the Metropolitan Traction Co., New York City, the Detroit United Railway Co., the Southern California Edison Co., Los Angeles.

Since that time Mr. Foster had been working on valuation of public utilities and studying traffic conditions and other matters pertaining to public service, being engaged in this work with J. G. White & Co. at the time of his death. Besides the "Electrical Engineer's Pocket-Book," Mr. Foster was the author of "Valuation of Public Utilities," and frequently contributed to the technical press. He was 55 years old and was a member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the Engineers' Club of New York and the Philadelphia Arts Club.

PERSONALS

J. B. Kitchen has been appointed engineer of operation of the Toronto (Ont.) Hydro-Electric System.

William D. Purcell has assumed charge of the rubber department of the Collieries Supply & Equipment Co., Philadelphia, Penn.

D. W. Roper, assistant chief operating engineer of the Commonwealth Edison Co., Chicago, has been elected chairman of the Chicago Section of the American Institute of Electrical Engineers.

Walter Knapp, formerly assistant shop superintendent of the machinery division at the Philadelphia Navy Yard, has accepted the position of chief engineer in the Cleveland office of the Standard Engineering & Drafting Co.

Frederick L. Ray, superintendent of the power plant of the Louisville (Ky.) Ry., won the first prize, $75, offered by the educational committee of the National Association of Stationary Engineers in its recent prize competition. Mr. Ray was successful in the advanced classification of the committee, in which thirteen papers were submitted, all of exceptional merit. Mr. Ray is chairman of the educational committee of Kentucky branch, No. 1, National Association of Stationary Engineers.

Seymour W. Cheney has been appointed operating engineer of the La Crosse (Wis.) Gas & Electric Co. Mr. Cheney is a graduate of the University of Wisconsin. He entered the gas and electric business in 1905 with the Denver (Colo.) Gas & Electric Light Co., and the following year was appointed superintendent of distribution of the Lincoln (Neb.) Gas & Electric Co. Later he held a similar position with the Montgomery (Ala.) Light & Power Co. Since 1910 he has been on the engineering staff of the Railroad Commission of Wisconsin, with headquarters in Milwaukee.

SOCIETY NOTES

The New Jersey State Association, N. A. S. E., will hold its annual banquet on Sunday afternoon, May 25, at the Continental Hotel, Newark. The dinner will conclude the convention, and a large attendance is expected.

NEW EQUIPMENT

ATLANTIC COAST STATES

Plans are being considered by the town council of Groton, Conn., for the installation of additional equipment in the municipal electric-light plant. T. A. Graves is superintendent of the plant.

The board of trustees of the Binghamton State Hospital, Binghamton, N. Y., are considering plans for the construction of a new power plant at the hospital. An appropriation of $60,000 was recently made for the purpose.

Estimates are being prepared by Horace G. Sweet, Utica, N. Y., of the cost of installing a municipal electric-light plant at Lyons, N. Y. Bonds to the amount of $10,000 have been voted for the purpose.

The common council of Newark, N. J., will investigate the cost of installing a new 50-kw. generator and engine in the City Hall lighting plant, to be used for supplementary service.

The West Penn Rys. Co. is planning extensive improvements to its power plant at Creighton, Penn. H. F. Banard, Pittsburgh, Penn., is purchasing agent.

SOUTHERN STATES

Plans are being prepared for the construction of an electric-light plant at Ravenswood, W. Va., for which J. Mentor Caldwell, Parkersburg, was recently granted a franchise.

Plans are being considered by the Monongalia Electric Co. for the construction of an electric-light plant at Star City, W. Va.

The Walterboro Ice & Light Co. is considering the construction of an electric-light plant at Walterboro, S. C. G. C. Brown is interested.

Bids will be received about June 30 for the construction of a municipal electric-light plant at Marshallville, Ga. Plans have been prepared by the J. B. McCrary Co., Atlanta, Ga.

The city of Lakeland, Fla., is planning extensive improvements to its municipal electric-light plant.

The Ball Creek Electric Co. is considering plans for the construction of an electric-light plant at Lone Mountain, Tenn. Payne Bros., of Lone Mountain, are interested in the project.

Extensive improvements are planned by the citizens of Paris, Tenn., to the municipal electric-light plant. M. W. Younkin is manager of the plant.

The B. F. McCormick Lumber Co., Winchester, Ky., will purchase ten electric motors for its planing mill, having decided to substitute central-station current for steam power.

CENTRAL STATES

Bids will be received by J. A. Wucher, clerk of the board of trustees of Jasper, Ind., until May 26, for furnishing equipment for the municipal electric-light plant. Paul H. White, Union Trust Bldg., Indianapolis, Ind., is consulting engineer.

The city council of Bloomingdale, Mich., has granted a franchise to Lewis K. Hawk, to construct and operate an electric-light plant.

Explosion and fire, May 7, destroyed the plant of the Lapeer Gas & Electric Co., Lapeer, Mich., with loss of $50,000.

It is reported that the Illinois Northern Utilities Co. will expend $100,000 for the construction of a new power plant at Belvidere, Ill.

Plans are being prepared by C. C. Chapman, Chicago, Ill., for the construction of a municipal electric-light plant at Elgin, Ill.

George Loptein has been granted a franchise to construct and operate an electric-light plant at Warren, Ill.

A new 225-hp. Diesel engine and a direct-current gen-

erator will be installed at the city water and lighting plant at Menasha, Wis.

WEST OF THE MISSISSIPPI

The new owners of the local electric-light plant at What Cheer, Iowa, are considering plans for the improvement of the plant and the extension of the system.

Preliminary arrangements are being made for the improvement and installation of new equipment in the municipal electric-light plant at Jackson, Minn. J. E. Barrett is superintendent of the plant.

Bonds to the amount of $19,000 have been voted for the construction of a municipal electric-light plant at Albany, Mo.

Preliminary arrangements are being made for the improvement of the municipal electric-light plant at Rolla, Mo. O. W. Chapin is superintendent of the plant.

Plans are being prepared for the installation of additional equipment in the municipal electric-light plant at Argenta, Ark. S. J. Chapman is manager of the plant.

The Marvel Light & Power Co. is considering plans for the construction of an electric-light plant at Marvel, Ark. F. H. Webster has charge of the work.

The installation of an electric-light plant in connection with the water system at Supply, Okla., is under consideration.

Bids will be received by the Salt River Valley Water Users' Association until 2 p.m., June 5, for the construction of the Crosscut power plant at Phoenix, Ariz.

Plans are being prepared by the San Joaquin Light & Power Co. for the improvement of its power plants at McKittric and Midway, Calif. Jack Carter is local superintendent.

CANADA

Plans are being considered by the council of Sackville, N. B., for the construction of a municipal electric-light plant. Estimated cost, $70,000.

W. S. Fielding, of Ottawa, Ont., is interested in the construction of an electric-power plant at Lingan, N. S.

Bids are being received by the Canadian General Electric Co. for the construction of an addition to its transformer station at Peterborough, Ont.

Plans are being prepared for the reconstruction of the power plant at Dawson, Yukon Territory, Can., which was recently destroyed by fire with a loss of $200,000.

The city council of Regina, Sask., is considering plans for the construction of a municipal electric-light plant, to cost $10,000.

Plans have been prepared for the construction of an engine and boiler house on Dewdney St., Regina, Sask., for the Regina Brewing Co. Estimated cost, $6000.

BUSINESS ITEMS

The New York office of the Murphy Iron Works, Detroit, Mich., has been moved from 1871 Hudson Terminal Building to 901 Woolworth Building.

The Joseph Dixon Crucible Co., Jersey City, N. J., is sending on application a new booklet entitled "Graphite for the Boiler." It is full of good points on this important subject.

The American Engineering Co., Philadelphia, has just completed an additional erecting shop 150x80 ft., at their plant in Philadelphia, Penn., to care for the rapidly increasing sales of Taylor stokers.

The Nelson Valve Co., Chestnut Hill, Philadelphia, Penn., has established a branch office at 415 San Pedro St., Los Angeles, Calif., where the W. H. Gilbert Sales Co. will act as direct representatives for the state of California.

Among recent orders received by the Heine Safety Boiler Co., of St. Louis, Mo., is one from the H. J. Heinz Co., of "57 Variety" fame, for five 607-hp. boilers, totalling 3035 boiler hp., for installation in their new plant at Pittsburgh.

The Power Specialty Co., 111 Broadway, New York, is building a new erecting shop, made necessary because of the rapid increase in the demand for Foster superheaters, for which recent orders for 77,426 hp. have been received.

The Spray Engineering Co., 403 Boston Safe Deposit & Trust Co. Building, Boston, Mass., will in the future be represented in New York by B. C. Donham & Co., 52 Broadway, and in Pittsburgh, Penn., by J. H. Lakin, Fulton Building.

"How to Make Your Canvas Belts Do Best Work" is the title of a 12-page booklet published by the Cling-Surface Co., Buffalo, N. Y. The booklet is well illustrated, and is full of good, sound, technical arguments and data that should appeal to belt men.

Due to the rapid increase in sales for high vacuum condensing apparatus and Rotrex air pumps the C. H. Wheeler Manufacturing Co., of Philadelphia, are making extensive enlargements and improvements to their works. They have increased the capital stock of the company from $200,000 to $600,000.

G. L. Simonds & Co., 115 South La Salle St., Chicago, Ill., representing the Vulcan Soot Cleaner Co., has recently received another order for 12 Vulcan soot cleaners for Stirling boilers from the Edison Illuminating Co. of Detroit. This is the eighth repeat order in seven years, and makes a total of 46 cleaners ordered in that time. The United Gas Improvement Co., of Philadelphia, have just placed two more orders with a total of nine Vulcan soot cleaners, this being the third order received from them within the last two years.

"Noiseless Gear Driving" is the title of a 56-page book issued by the New Process Gear Corporation, Syracuse, N. Y. It contains sound engineering arguments for rawhide gears, proves that they are of important economic value in any plant where high-speed gears are used, gives much transmission data, and is profusely illustrated with photographs of actual installations. Sections of 11 types of rawhide gears are shown and prices on nearly 2000 sizes of pinions are given, which are either in blank or cut and ready for use. It is sent on request.

WANTS

Positions Wanted, three cents per word, each insertion
Positions Open, five " " " " "
For Sale, five " " " " "
Miscellaneous, ten " " " " "
No abbreviated words allowed.
Count three words for keyed address.
All advertisements payable in advance.

Copy should reach us not later than Tuesday 10 A. M., for ensuing week's issue. Answers addressed to our care, 505 Pearl St., New York, will be forwarded.
No information given by us regarding any advertiser's address.
Original letters of recommendation or other papers of value should not be inclosed to unknown correspondent.
No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for positions.

POSITIONS OPEN

SALESMAN—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M.M. Co.," Power.

POWER SOLICITOR for electric central station in western Pennsylvania; state experience, age, education and salary expected. Address W. R. Kenney, Post Office Box 862, Connellsville, Penn.

CHIEF ENGINEER for small central station about 50 miles from New York; Corliss engine belted to alternators; salary, $75 per month to start. Address E. C. Brown, 140 Ferry St., Easton, Penn.

AGENTS to sell on commission mechanical draft blowers; prefer men who handle on similar basis sales of grate bars, tube cleaners or other boiler accessories; hustlers wanted; state experience and territory worked. P. 855, Power.

OFFICE CLERK; state age, experience, salary expected; give reference and what church you attend; hardware supply business; must be good penman and correct at figuring. Address "Rekcutaw," P. O. Box 5, Station S, New York City.

POSITIONS WANTED

THE SERVICES OF A YOUNG MECHANICAL ENGINEER with seven years' shop and designing experience on high-speed machinery and steam turbines can be secured by writing P. W. 895, Power.

MECHANICAL ENGINEER, technical graduate, eight years' experience; at present in charge of engineering and sales for contracting business in Chicago; desires proposition as sales engineer. P. W. 896, Power.

FOR SALE

20x42 LANE & BODLEY HEAVY DUTY CORLISS ENGINE; condition like new; $900. Eastern Machinery Exchange, 171 Broadway, New York.

14x32 WATTS CAMPBELL CORLISS ENGINE, perfect condition; must move immediately; $550. Duzets & Son, Hudson Terminal, New York.

16x30 FULTON CORLISS ENGINE, available for shipment in about 30 days; engine in first-class condition; bargain. Laporte Gas & Electric Co., Laporte, Ind.

ONE 30-HP. LINCOLN MOTOR, three phase, 60 cycle, 220 volt, speed 1200 r.p.m., with compensator; motor run about four months; excellent condition. Address Maton & Mitchell, Waterbury, Conn.

TWO TUBULAR BOILERS, 48 in. in diameter, 20 ft. long, twelve 6-in. tubes; are in use now, but will be replaced by larger boiler; working pressure, 105 lb. Address Aviston Milling Co., Aviston, Ill.

IDEAL ENGINE, direct-connected 50-kw. generator; Ideal engine, direct-connected 25-kw. generator; Bullock generator, 65 kw., connected to engine; two motor-driven exhaust fans; 300-hp. Berryman heater. H. P. Brearley, 90 West St., New York.

CORLISS ENGINES—10x30 St. Louis, 12x36 St. Louis, 18x36 St. Louis, 26x48 Fil.&S., 26&42x48 Cross Compound, $1400, bargain, 30&30x60 Reynolds, 32&32x60 Reynolds. Send for our complete list of Engines, Boilers, Generators, etc. Harold R. Wilson Machinery Co., St. Louis.

A NUMBER OF 110- AND 220-VOLT D.C. MOTORS, from ¾ to 20 hp.; a number of 110-volt multiple Jandus arc lamps; also a number of General Electric T and H 12-hour series arc lamps; all in good condition. For particulars apply or write Aberfoyle Mfg. Co., Chester, Penn.

ONE ENGINE-GENERATOR unit, consisting of Russell simple, high-speed, single-valve, inclosed engine, direct connected to 75-kw., 110-volt direct-current Crocker-Wheeler generator; in excellent condition; immediate delivery. For full particulars address the Griscom-Russell Co., 2116 West St. Building, New York.

AT A DECIDED BARGAIN—Three 100-kw. oil insulated self-cooling Westinghouse transformers, single-phase, 25-cycle, 12,000 volts high tension, 440 volts low tension; these transformers are in first-class condition; reason for selling, require more capacity. Address Northern Coal & Dock Co., Superior, Wis., or St. Paul, Minn.

MISCELLANEOUS

PATENTS SECURED—C. L. Parker, Patents 904 G St. Washington, D. C.

A RESPONSIBLE CONCERN of 30 years' standing, wishes to add a specialty of merit that can be sold to the steam trade in New York City and vicinity. M. 897, Power.

WANTED—Machine works to manufacture two inventions pending the installation of special machinery in our own plant. Address Lawrence Manufacturing Co., Key West, Fla. New York office, care Geo. H. Mann, 71 Wall St.

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